Advant® OCS
with Master software

Advant® Controller 160

Version 2.0

User’s Guide

3BDS 005 555R101

Use of **DANGER**, **WARNING**, **CAUTION**, and **NOTE**

This publication includes, **DANGER**, **WARNING**, **CAUTION**, and **NOTE** information where appropriate to point out safety related or other important information.

DANGER	Hazards which could result in severe personal injury or death
WARNING	Hazards which could result in personal injury
CAUTION	Hazards which could result in equipment or property damage
NOTE	Alerts user to pertinent facts and conditions

Although **DANGER** and **WARNING** hazards are related to personal injury, and **CAUTION** hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all **DANGER**, **WARNING**, and **CAUTION** notices.

TRADEMARKS

ABB Master is a registered trademark of ABB Asea Brown Boveri Ltd. Switzerland.

Advant is a registered trademark of ABB Asea Brown Boveri Ltd. Switzerland.

MODBUS is a registered trademark of Gould Electronics Inc.

Siemens and all Siemens-products mentioned in this publication are trademarks of Siemens AG.

NOTICE

The information in this document is subject to change without notice and should not be construed as a commitment by ABB Automation Products GmbH. ABB Automation Products GmbH assumes no responsibility for any errors that may appear in this document.

In no event shall ABB Automation Products GmbH be liable for direct, indirect, special, incidental or consequential damages of any nature or kind arising from the use of this document, nor shall ABB Automation Products GmbH be liable for incidental or consequential damages arising from use of any software or hardware described in this document.

This document and parts thereof must not be reproduced or copied without ABB Automation Products GmbH’s written permission, and the contents thereof must not be imparted to a third party nor be used for any unauthorized purpose.

The software described in this document is furnished under a license and may be used, copied, or disclosed only in accordance with the terms of such license.

Copyright © ABB Automation Products GmbH 2000

3BSE001264/E

Template: 3BSE001286/E

TABLE OF CONTENTS

Chapter 1 - Introduction

1.1 Before You Begin 1
1.2 Equipment Requirements 2
1.3 How to Use this Book 2
1.4 Conventions 5
1.5 Related Documentation 5
1.6 Release History 7
    1.6.1 Release Designation 7
    1.6.2 Product Releases 8
    1.6.3 Differences Advant Controller 160/Advant Controller 110 12
1.7 Terminology 14
1.8 Product Overview 18
    1.8.1 Product Structure 19
    1.8.2 General System Utilities 23
    1.8.3 Power Supply 31
    1.8.4 Process Interface 31
    1.8.5 Communication 32
    1.8.6 Process Control 32
    1.8.7 Operator Interface 34
    1.8.8 Mechanics 35

Chapter 2 - Installation

2.1 Site Planning 37
    2.1.1 Site Selection and Building Requirements 37
    2.1.2 Environmental Considerations 38
    2.1.3 Electromagnetic Compatibility 39
    2.1.4 Standard Layout and Disposition of Cabinets 40
    2.1.5 Grounding 42
    2.1.6 Cables 43
    2.1.7 Power Supply and Fusing 43
    2.1.8 Process Connection 45
    2.1.9 Hazardous Applications 46
    2.1.10 High Voltage Switch-gear Applications 46
    2.1.11 Lightning Strike Protection 46
    2.1.12 Weight and Mounting Dimensions 47
    2.1.13 Transportation and Storing 48
2.2 Installation Procedures 49
    2.2.1 Safety Regulations 49

2.2.2 Unpacking and Storing 51
2.2.3 Location 52
2.2.4 Erecting the Cabinets 52
2.2.5 Cabinets Screwed Together 53
2.2.6 Fixing Cabinet to Floor 53
2.2.7 Grounding 57
2.2.8 Cable Routing in Cabinets 64
2.2.9 Radio-Proof Cabinet 66
2.2.10 Power Supply Connection 66
2.2.11 Bus Connection to Extension Subrack 72
2.2.12 Basic Station 72
2.2.13 Bus Extension to S600 I/O 73
2.2.14 S600 I/O 75
2.2.15 S800 I/O 90
2.2.16 Panels 90
2.2.17 Communication 92
2.2.18 Engineering Station 92
2.2.19 Checklists 93
2.2.20 Final Procedures Before Start-up 99
2.3 Shut-down Procedures 99
2.3.1 Safety Regulations 99
2.3.2 Controller and I/O 99
2.3.3 Peripheral Equipment 102
2.4 Start-up Procedures 103
2.4.1 Safety Regulations 103
2.4.2 Loading or Upgrading of System Software and its Options 104
2.4.3 Controller and I/O 107
2.5 Product Verification 111
2.5.1 Safety Regulations 112
2.5.2 Servicing Tool 112
2.5.3 Commissioning 112
2.5.4 Final Control 124
2.6 Implementation of Functions in Systems Already Operating 125
2.6.1 Servicing Tool 125
2.6.2 Safety Regulations 125
2.6.3 General Guidelines 126
2.6.4 Additional I/O Modules 127
2.6.5 Loading or Upgrading Additional System Software Options 129

Chapter 3 - Configuration

3.1 Considerations 130
  3.1.1 Product Structure 130
  3.1.2 General System Utilities 137
  3.1.3 Power Supply 139
  3.1.4 Process Interface 142
  3.1.5 Communication 153
  3.1.6 Process Control 174
  3.1.7 Operator Interface 183
  3.1.8 Heat Dissipation 188
  3.1.9 Module Types and Programming Style 190
  3.1.10 Expansion Possibilities and Spare Considerations 191
  3.1.11 Availability and Safety 191
  3.1.12 System Clock Synchronization 212
  3.1.13 Memory Requirement 216
  3.1.14 CPU-Optimization, Load Calculation 217
3.2 Capacity and Performance 221
  3.2.1 Product Structure 221
  3.2.2 General System Utilities 221
  3.2.3 Power Supply 224
  3.2.4 Process Interface 225
  3.2.5 Communication 227
  3.2.6 Process Control 228
  3.2.7 Operator Interface 229
  3.2.8 Availability 230
  3.2.9 Mechanics 230
3.3 Database Configuration 235
3.4 Tutorial 235
  3.4.1 Introduction to the Design 236
  3.4.2 Design Procedures 236

Chapter 4 - Runtime Operation

4.1 Operating Overview 240
4.2 Operating Instructions 240
4.3 Product Operation 240
  4.3.1 Working Modes 240
  4.3.2 Ordering Working Modes 241
  4.3.3 Start Modes 241
  4.3.4 Relation between Start Modes and Working Modes 242
  4.3.5 Engineering Station Commands and Working Modes 244
  4.3.6 System States 245

4.3.7 System Software 246
4.3.8 Application Program 250

Chapter 5 - Maintenance

5.1 Preventive Maintenance 256
5.1.1 Safety Regulations 256
5.1.2 Visual Inspection 257
5.1.3 Safety 258
5.1.4 Cleanliness 258
5.1.5 Air Filter 258
5.1.6 Forced Cooling 258
5.2 Hardware Indicators 258
5.2.1 Indication on the Module Front of S600 I/O Modules 258
5.3 Error Messages 259
5.3.1 Fault Classification 259
5.3.2 Error Types 260
5.3.3 Error Report 261
5.3.4 Module Diagnostic 263
5.3.5 Faults Stopping the System 264
5.3.6 Faults Not Stopping the System 271
5.4 Fault Finding and User Repair 282
5.4.1 Introduction 282
5.4.2 Diagnostics 283
5.4.3 Fault Tracing Principles 284
5.4.4 Start-up 285
5.4.5 Safety 285
5.4.6 Process Output Behavior 285
5.5 Basic Fault Tracing 285
5.5.1 Equipment 285
5.5.2 Fault Tracing Procedure 285
5.6 Advanced Fault Tracing 299
5.6.1 Fault Tracing by Interpretation of Fault Symptoms 300
5.6.2 Voter Test 300
5.7 User Repair 301
5.7.1 Module Replacement 301
5.8 Calibration of Analog Input and Outputs 306

Appendix A - Hardware Components

A.1 Hardware Components listed in Alphabetical Order 307
A.2 Hardware Components listed in Functional Order 310

Appendix B - Processor Modules

B.1 PM640....................314
B.2 PM644....................320
B.3 PM645....................328
B.4 PM646....................339

Appendix C - Cabinet Configuration

C.1 Single Cabinet Configuration....................349
C.2 Maximum Cabinet Configuration....................350
C.3 Power Supply Units SA16x and SA17x....................351
C.4 Distribution Units for Cabinets....................352

Appendix D - Delivery Documentation

D.1 Delivery Binder Content....................355

ILLUSTRATIONS

Figure 1-1. Advant OCS Family with Advant Controller 160 1
Figure 1-2. Hardware Manual Organization Structure.. 2
Figure 1-3. Example of Release Designation for Base Software 7
Figure 1-4. Advant Controller 160, Example of Physical Appearance........................... 18
Figure 1-5. Advant Controller 160 System Structure (Redundant Configuration) 22
Figure 1-6. Example of PC Elements (AND, TON, SHIFT)... 33
Figure 1-7. An Advant Controller 160 Configuration.. 35
Figure 2-1. Standard Cabinet Configuration (Maximum)... 41
Figure 2-2. Grounding of Electronic Equipment.. 42
Figure 2-3. Minimum Distance to Ceiling.. 47
Figure 2-4. Minimum Distance from Rear of Cabinet to a Wall..................................... 48
Figure 2-5. Warning Label regarding ESD... 51
Figure 2-6. Cabinet Leveling Screws 52
Figure 2-7. Screwed Connections.. 53
Figure 2-8. Screwing of Cabinet to Floor.. 54
Figure 2-9. Screwing through Holes in Bottom 55
Figure 2-10. Fixing of Cabinet by Welding to Steel Section... 55
Figure 2-11. Fixing of Cabinet to Computer Room Floor, Variant 1 56
Figure 2-12. Fixing of Cabinet to Computer Room Floor, Variant 2 56
Figure 2-13. Handling of Cable Shields in a CE-marked Cabinet (Example with S600 I/O).. 59
Figure 2-14. Handling of Cable Shields in a not CE-marked Cabinet 60
Figure 2-15. Principles of Grounding of Communication Cable Shields in a CE-marked Design... 61
Figure 2-16. Communication Cable Shield Grounded by Capacitor................................. 62
Figure 2-17. Assigned Space for Cables in a Cabinet 65
Figure 2-18. Main Principle of Power Supply Connection and Distribution 66
Figure 2-19. Advant Controller 160 basic Station Configured with Two Power Supply Modules SA610... 68
Figure 2-20. SA610 Connections for Single Configuration... 69
Figure 2-21. SA610 Connections for Parallel Configuration for Increased or Redundant Power Supply... 70
Figure 2-22. Connection of Run/Alarm Relay 73
Figure 2-23. Example of Bus Extension (Non redundant Configuration).......................... 74
Figure 2-24. I/O Module with Process Connector... 76
Figure 2-25. Process Connector with Screw Terminals 78
Figure 2-26. Process Connector with Crimp Terminals 80
Figure 2-27. I/O Module with Front Door Closed... 82
Figure 2-28. I/O Module with Front Door Open 83

Figure 2-29. Basic Subrack RF616 for Basic Station 85
Figure 2-30. Basic Subrack RF615 for I/O 86
Figure 2-31. Extension Subrack RF620 for Base or I/O Station 86
Figure 2-32. Module Fixing Screw when Mounting the Module on the Subrack 87
Figure 2-33. Carrier Module SC610 and Submodule CI532 Mechanics 88
Figure 2-34. Supply of a Panel Without Modem 91
Figure 2-35. Power-up, Circuit Breakers and Positive Indications 108
Figure 2-36. Example of Display and Force Values 116
Figure 2-37. Testing Digital Input Signals 121
Figure 2-38. Testing Analog Input Signals 122
Figure 2-39. Testing Digital Output Signals 123
Figure 2-40. Testing Analog Output Signals 124
Figure 3-1. Example of Advant OCS System Structure with Advant Controller 160 131
Figure 3-2. Block Diagram of Advant Controller 160 with Processor Module PM640 . 132
Figure 3-3. Block Diagram of Advant Controller 160 with Processor Module PM644 . 133
Figure 3-4. Block Diagram of Advant Controller 160 with Processor Module PM645 . 134
Figure 3-5. Block Diagram of Advant Controller 160 with Processor Module PM646 . 135
Figure 3-6. Advant Controller 160 Functional Interfaces 136
Figure 3-7. External Synchronization of System Clock 137
Figure 3-8. Connection of Run/Alarm Relay 138
Figure 3-9. Input and Output Signal Paths (in Principle) 144
Figure 3-10. Processing Chain for Analog Input from AX645 146
Figure 3-11. Processing Chain for Analog Output to AX645 147
Figure 3-12. Connection to AI610 148
Figure 3-13. Example of an Advant Controller 160 Configuration with Two I/O Stations and Non Redundant I/O Extension 161
Figure 3-14. Advant Controller 160 Configuration with Two I/O Stations and Redundant I/O Extension 162
Figure 3-15. Dual Advant Fieldbus 100 Configuration 165
Figure 3-16. 4x Advant Fieldbus 100 (one Redundant) 166
Figure 3-17. Data Transmission via HSL with Three CPUs 168
Figure 3-18. Example of an MVI-Siemens 3964(R) Configuration 171
Figure 3-19. Example of an MVI-MODBUS Configuration 172
Figure 3-20. Example of an PROFIBUS-DP Configuration 173
Figure 3-21. Example of PC Diagram of an AMPL Program 175
Figure 3-22. Simple Control Function Realized in AMPL 176
Figure 3-23. User Application Program for Advant Controller 160 177
Figure 3-24. Configuration Part Within the User Application Program 178
Figure 3-25. Program Part Within the User Application Program 179

Figure 3-26. Example of a PC Element in Graphical Representation 179
Figure 3-27. Reduction Factors for Cabinets Installed in Groups.................................... 189
Figure 3-28. Dual Redundant Processor Module within One Advant Controller 160 195
Figure 3-29. Triple Redundant Configuration with Three Advant Controllers 160......... 197
Figure 3-30. Dual Parallel Processor Module within One Advant Controller 160 200
Figure 3-31. Triple Parallel Configuration with Three Advant Controllers 160 Operating in Parallel, Data Exchange via High Speed Serial Links............ 201
Figure 3-32. Triple Parallel Configuration with Three Advant Controllers 160 Operating in Parallel, Data Exchange via High Speed Serial Links............ 202
Figure 3-33. Dual Redundant Processor Module within One Advant Controller 160 203
Figure 3-34. PC Element MOVERED for Unplanned Redundancy shown within Slave CPU 205
Figure 3-35. Planned High Speed Link Connection with HSLS and HSLR.................... 206
Figure 3-36. Planned Signal Exchange of a 1 out of 2 Redundant CPU.......................... 207
Figure 3-37. Example of PC Diagram of a Redundant MODBUS Application, Part 1 ... 210
Figure 3-38. Example of PC Diagram of a Redundant MODBUS Application, Part 2 211
Figure 3-39. System Clock Synchronization within an Autonomous Control System using AC 160 and AdvaSoft 2.0 for Windows NT...................................... 213
Figure 3-40. System Clock Synchronization within a Control System using AC 160 with Superordinate AC 450 and AS 500OS................................... 214
Figure 3-41. Time Synchronization of Several Processor Modules................................. 215
Figure 3-42. Advant Controller 160 Priority System 217
Figure 3-43. Structuring Limits 229
Figure 3-44. Controller Subrack and Cable Duct, Dimensions.. 232
Figure 3-45. Basic Station, Example for Position Disposition.. 233
Figure 3-46. Basic Station, Position Disposition... 234
Figure 3-47. Example of Designations in a Feedback Control Loop 239
Figure 4-1. Example of Diagnostic Display Indicating System States........................... 242
Figure 4-2. Block Diagram of Advant Controller 160 Software.................................... 248
Figure 4-3. Function Consisting of Two Executable Units 251
Figure 4-4. Printout of the Tree Diagram 252
Figure 4-5. Order of Execution for PC Elements, AND Gate with Two Inputs............. 253
Figure 4-6. Example of Reading-in Phase... 254
Figure 4-7. Example of Reading-out Phase... 255
Figure 5-1. Warning Label Regarding ESD 257
Figure 5-2. Example for Report Error Window.. 262
Figure 5-3. Example for Module Diagnostics of Device Object.................................... 263
Figure 5-4. Fault Tracing Procedure... 286
Figure 5-5. Front and Rear Views of the Power Supply Module SA610 288
Figure 5-6. Processor Module PM640.. 290
Figure 5-7. Processor Module PM644.. 291

Figure 5-8. Processor Module PM645 292
Figure 5-9. Processor Module PM646 293
Figure 5-10. Bus Extender Module CI615 with Open Front Door and Front View 295
Figure 5-11. Signal Status and Fault Indication on the I/O Modules....................297
Figure 2-1. PM640 Front View 316
Figure 2-2. PM644 Front View 322
Figure 2-3. Speed Input Pulses versus Time 326
Figure 2-4. PM645 Front View 331
Figure 2-5. Speed Input Pulses versus Time 337
Figure 2-6. PM646 Front View 342
Figure 3-1. Single Cabinet Configuration with Different Kinds of Power Supply.........349
Figure 3-2. Maximum Cabinet Configuration with Central Power Supply 350
Figure 3-3. Maximum Cabinet Configuration with Decentralized Power Supply..........351
Figure 3-4. Circuit Diagram of Distribution Unit SX540 352
Figure 3-5. Circuit Diagram of Distribution Unit SX542 353
Figure 3-6. Circuit Diagram of Distribution Unit SX554 354

TABLES

Table 1-1. Related Documentation 5
Table 1-2. Release History 8
Table 1-3. Differences between Advant Controller 160 and Advant Controller 110 12
Table 1-4. Basic Unit for Advant Controller 160 20
Table 1-5. CPU Memory 25
Table 1-6. PC Elements of the BASE System Software 27
Table 1-7. PC Elements of the Option OPT1 Extended PC Element Set 29
Table 1-8. PC Elements in the Program Module OPT6 29
Table 1-9. Number of Buses and Links that can be connected to Advant Controller 160 32
Table 2-1. Methods of Handling Communication Cable Shields 62
Table 2-2. Cable Categories in a Cabinet 65
Table 2-3. Process Connectors and Cables 79
Table 2-4. Grounding Philosophy, Earthing Line System 93
Table 2-5. Process Cabling, Shielding, Grounding, max. Length 94
Table 2-6. Supply 95
Table 2-7. Lightning Protection 95
Table 2-8. Subrack, Connection, Module 96
Table 2-9. Cabinets, Internal Cables 96
Table 2-10. Communication, Communication Cables 98
Table 2-11. Corrosive Gases 98
Table 2-12. Miscellaneous 99
Table 2-13. Implementation of Functions in Systems Already Operating 127
Table 3-1. Communication Survey 153
Table 3-2. Link Types, Hardware and Software for Advant Controller 160 154
Table 3-3. Applied Communication, Used Links and Interface to Application Program 157
Table 3-4. Distances based on transmission speed. 173
Table 3-5. Configuration of Sequence Control 183
Table 3-6. Data Base Elements for MODBUS 184
Table 3-7. Communication Settings for MODBUS 185
Table 3-8. MODBUS Functions 186
Table 3-9. Max Permitted Power Dissipation, RM5yy Cabinet 188
Table 3-10. System Time Masters for Synchronization via AF 100 212
Table 3-11. Connection Hopf 7001 DCF to Com B 215
Table 3-12. Technical Data of the Processor for the Application Program 221
Table 3-13. Maximum usable CPU Load for Application Program 222
Table 3-14. General Technical Data, Capacity of Memory 222

Table 3-15. PM645/PM646 Clock Synchronization, Electrical Data for Minute Pulse..223
Table 3-16. Estimated System Power Consumption..224
Table 3-17. Size of Event Queue for Event Burst 225
Table 3-18. Relative Time Errors of Time-tagged Events...225
Table 3-19. Capacity S600 I/O for Advant Controller 160 226
Table 3-20. Link Types, Hardware and Software...227
Table 3-21. Data Set Communication for Advant Controller 160...................................228
Table 3-22. Key Data, Process Control 228
Table 3-23. Cabinet Dimensions...230
Table 3-24. Protection Rating...231
Table 3-25. Controller Subrack Dimensions 231
Table 3-26. Position Disposition for Basic Subrack in the Basic Station........................233
Table 3-27. Position Disposition for Basic Subrack of the I/O Station...........................234
Table 3-28. Position Disposition for Extension Subrack of the Basic or I/O Station......235
Table 4-1. Start Modes of the Processor Module. 241
Table 4-2. List of System States Advant Controller 160..245
Table 5-1. Error Types Advant Controller 160...260
Table 5-2. List of Module Object Types...264
Table 5-3. Error Codes on Diagnostic Display of Processor Module............................265
Table 5-4. Error Texts in Error Report..271
Table 1-1. Hardware Components listed in Alphabetical Order....................................307
Table 1-2. Hardware Components listed in Functional Order.......................................310
Table 2-1. PM640 Technical Data 314
Table 2-2. PM644 Technical Data 320
Table 2-3. Connector Allocation of Rotational Speed Inputs..327
Table 2-4. PM645 Technical Data 329
Table 2-5. PM645 Versions..332
Table 2-6. Predefined Pin-Out for I/O Port 337
Table 2-7. Connector Allocation of Rotational Speed Inputs..338
Table 2-8. PM646 Technical Data 340
Table 2-9. PM646 Version 344
Table 2-10. Predefined Pin-Out for I/O Port 348
Table 3-1. Overview Technical Data for Power Supply SA16x and SA17x 351
Table 3-2. List of Distribution Units..352

Chapter 1 Introduction

1.1 Before You Begin

Advant OCS is a system for industrial automation. It consists of a family of computer-based units and a local area network for communication. A controller is a computer-based unit in which control applications are running.

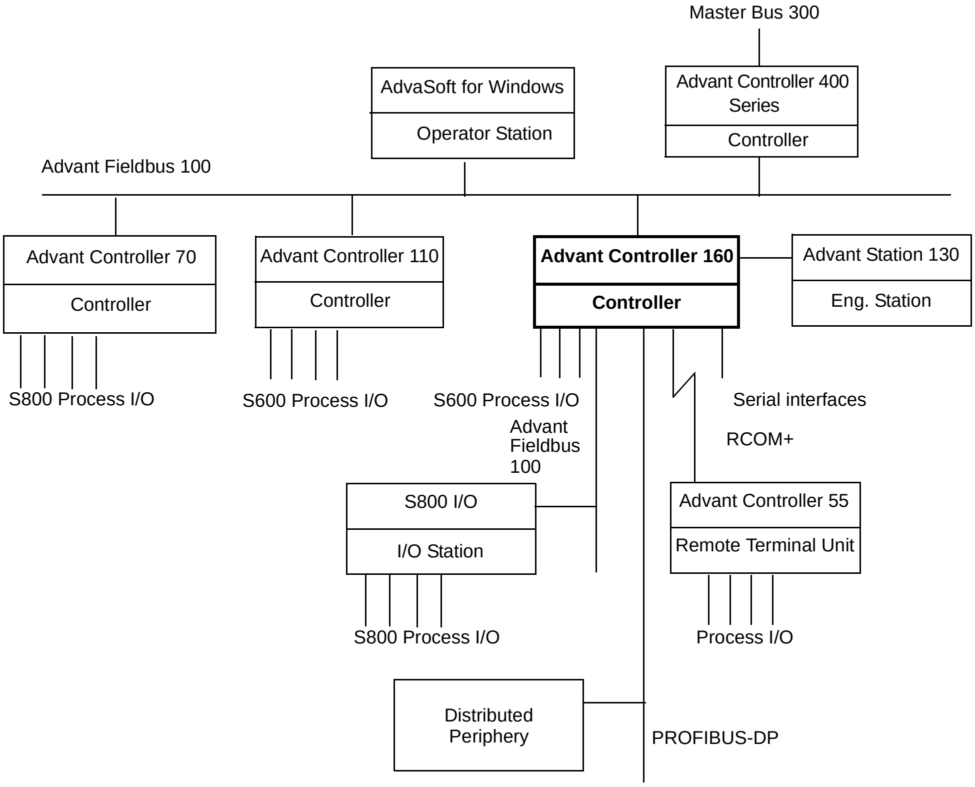


Figure 1-1. Advant OCS Family with Advant Controller 160

Advant Controller 160 is a high performance controller with redundancy and multiprocessing for mixed binary, regulatory and supervisory control. It can be used as a stand-alone station, or as an integrated controller in a distributed control system, communicating with other components of the Advant Open Control system (see Figure 1-1).

This manual is intended primarily for plant designers and commissioning and maintenance personnel, providing them with information about Advant Controller 160 system, its capabilities and its limitations.

References are made to other manuals when necessary. Section 1.3, How to Use this Book provides further details about both this manual and other related manuals.

NOTE

> The cabinets described in the document are outfaced. The ordering numbers and a brief description of the new cabinets can be found in the *Advant Controller 160 Product Guide*.

1.2 Equipment Requirements

Not relevant to this type of system product.

1.3 How to Use this Book

Basic Structure

This book is organized into chapters and sections as shown in Figure 1-2. Each document describing and referencing hardware, is built around this structure to make it easy for you to locate related information in any of the documents. Since this one structure is not completely applicable to all type of hardware, certain sections contain only very brief statements in some documents. Small divergences from the standard structure are given in italics in Figure 1-2.

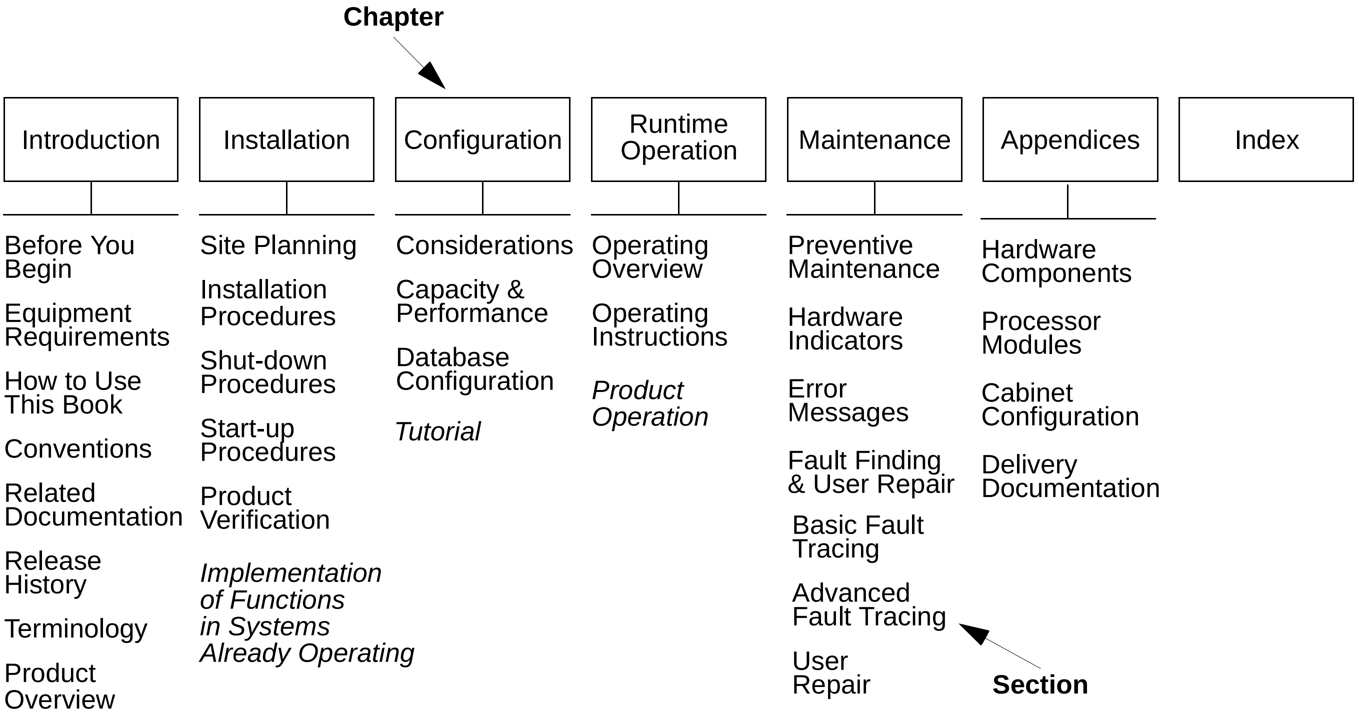


Figure 1-2. Hardware Manual Organization Structure

The substructure followed in the product description in Section 1.8, Product Overview is also followed in other sections describing, for example, Considerations and Capacity & Performance. This is done to make it easy for you to find the information you need about different activities.

Because of the activity-oriented structure of the document, you may find information regarding an actual function distributed to, for example, Overview, Configuration, Operation, and so on. Sometimes you can find device information gathered in the hardware descriptions in the appendices.

Introduction

Chapter 1, Introduction (this chapter) provides introductory and background information, including:

- Guidelines on how you can find information in this manual.
- This manual's relationship to other Advant Controller 160 documents.
- A glossary defining terms frequently used in this manual.
- A product and functional overview. Read this to get an idea of what Advant Controller 160 can do and how it works.

Installation

Chapter 2 guides you through various installation activities:

- Section 2.1, Site Planning. This section contains guidelines for planning installation of the product, outlining what you need to think about when you plan an installation. It does not, however, provide the complete list of measures to take. You can find descriptions of alternative solutions, design considerations, and so on, elsewhere in this manual.
- Section 2.2, Installation Procedures. This section gives you concrete information on how to set up the product. It includes safety regulations, handling and unpacking instructions, inspection and assembly procedures, cable routing and connections, switch settings and jumper positions, setup procedures, and so on. You can find common instructions as well as instructions for specific subsystems in this section. Activities prior to power-up are also described.
- Section 2.3, Shut-down Procedures. This section provides, in addition to some safety regulations, basic shut-down procedures. You should know how to shut down the product if there is a problem with initial power-up.
- Section 2.4, Start-up Procedures. In Section 2.2, Installation Procedures, the conditions and the preparation necessary to begin are discussed. In Section 2.4, Start-up Procedures, you can find basic power-up procedures, that is, how to apply power to and initialize the system. Information is also given on how you can verify a correct start. You can find information on activities up to "ready for application program loading" in this section.
- Section 2.5, Product Verification. This section tells you how to make an initial determination that the product is functional. This includes application program loading as well as commissioning information.
- Section 2.6, Implementation of Functions in Systems Already Operating. This section gives you the information you need to determine when, for example, to add an I/O board to a running system. Important on-line, off-line aspects are discussed.

Configuration

Chapter 3 gives you detailed information about how to obtain a desired function. The main information is structured as follows:

- Section 3.1, Considerations. You can find design guidelines, including design rules, in this section. Keywords include the following:
  - Limitations
  - Combinations of options
  - Module assortment supported by the system product
  - Location
  - Necessary extra HW and SW needed with respect to desired functionality
  - CPU load calculation
  - Memory calculation.
- Section 3.2, Capacity and Performance. In this section, technical data of the following types are discussed:
  - Maximum number of instances
  - Dimensions
  - CPU load data
  - Memory capacity.
- Section 3.3, Database Configuration. In this section appropriate reference documents are listed.
- Section 3.4, Tutorial. This Section provides you with a guide through the different phases of a controller design project.

Runtime Operation

This chapter addresses the controller's different start modes and working modes. The operator interface on the Processor Module front is described.

In this chapter, you can also find a survey of the system software. Some important facilities that you need to know during application work are described in greater detail.

Maintenance

The preventive maintenance required for electronic equipment is not significant. This chapter focuses on fault finding supported by built-in diagnostics. Various methods of fault announcement are presented, including the use of error report in the Engineering Station, system status in the operator station, and LED's on controller hardware units.

Appendices

Informations which do not fall into other categories within this manual's structure are included in the appendices. Examples are:

- Processor Module descriptions
- Cabinet configurations
- Description of delivery documentation.

Index

The Index offers you an easy and quick way to find answers to specific questions.

1.4 Conventions

Not relevant in this document.

1.5 Related Documentation

This manual is the main document of the system product Advant Controller 160. Many of the available options are briefly described in this manual. For additional detailed information about options, see the appropriate individual manuals. Special subjects are also thoroughly treated in separate documentation as listed in Table 1-1.

Table 1-1. Related Documentation

Document	Description
Advant Controller 160 Version 2.0 Product Guide 3BSE 014 721R101	Describes the product Advant Controller 160 version 2.0.
Data Base Elements Advant Controller 160 Reference Manual 3BDS 005 556R101	Describes all Data Base elements used in Advant Controller 160.
PC Elements Advant Controller 160 Reference Manual/Rev B 3BDS 005 557R101	Describes all PC elements used in Advant Controller 160.
S600 I/O Hardware Reference Manual 3BSE 011 123R1	Describes all S600 I/O Modules used both in Advant Controller 110 and 160.
S600 I/O Hardware Advant Controller 160 Reference Manual 3BDS 005 558R101	Describes all S600 I/O Modules used in Advant Controller 160 only.
S800 I/O User's Guide 3BSE 008 878R201	Describes all S800 I/O Modules.
Advant Fieldbus 100 User's Guide 3BSE 000 506R701	Describes the Advant Fieldbus technology.

Table 1-1. Related Documentation (Continued)

Document	Description
PROFIBUS-DP Advant Controller 110/160 User's Guide 3BDS 100 313R301	Describes the PROFIBUS-DP interface of Advant Controller 110 and Advant Controller 160 2.0.
PROFIBUS-DP Advant Controller 160 User's Guide 3BDS 005 500R1 (*replaced by PROFIBUS-DP Advant Controller 110/160 User's Guide*)	Describes the PROFIBUS-DP interface of Advant Controller 160 1.1 and 1.2.
MODBUS Panel Connections Advant Controller 100 Series User's Guide 3DDS 004 129R401	Describes how to connect a panel to Advant Controller 100 Series using the MODBUS protocol.
AMPL Configuration Advant Controller 100 Series Reference Manual 3BSE 009 626R401	Describes how to create applications using AMPL.
Function Chart Builder Version 4.7 User's Guide 3BSE 007 149R801	Describes the graphical programming tool Function Chart Builder for Advant Controller 160.
Advant Workplace Products Administrator's Guide 3BSE 014 254R101	Describes the Advant Workplace products.
Advant Workplace Engineering Methods Reference Manual 3BSE 017 088R101	Describes the engineering methods of Advant Workplace.
Advant OPC Server for Advant Fieldbus 100 User's Guide 3BSE 013 896R1	Describes Advant OPC Server for AF 100.
Advant Controller 110 User's Guide 3BSE 009 131R101	Describes Advant Controller 110. Some information can be found here which is valid also for Advant Controller 160.

1.6 Release History

1.6.1 Release Designation

This manual describes the product Advant Controller 160∗2.0

The complete standard product including software, hardware and documentation is designated Advant Controller 160∗2.0/x, where x is the number for the revision.

The software included consists of base software and several software options. All base software and software options are designated in principle in the same way, for example, BASE SW∗2.0/0.

The designation of a complete standard product or a program module is divided into two parts by an asterisk.

The first part consists of a product name. The second part consists of a release number, minor release number and revision number. See Figure 1-3.

The options display on the configuration tool indicates, upon connection to the system, the current product releases of the program modules.

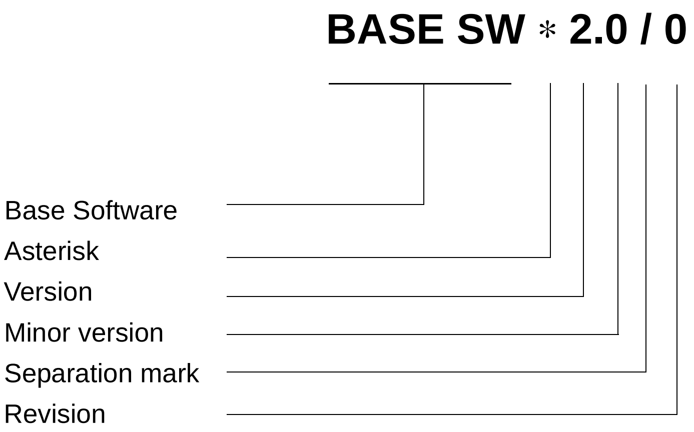


Figure 1-3. Example of Release Designation for Base Software

1.6.2 Product Releases

Release 2.0 is the fourth release of Advant Controller 160.

From a system viewpoint, the new controller version 2.0 is fully compatible to its previous version 1.2. This means that you can include new controllers in an available control network. Advant Controller 160 can run old application programs (if the functional libraries coincide).

Table 1-2 lists the versions and the newly added functions of Advant Controller 160∗2.0.

Table 1-2. Release History

Version	**Description**
1.0	First release of Advant Controller 160.
1.0/1	The new added functions are: • Update slave in CPU redundancy with the application program of the master with a “command” on the engineering tool on the master side • Supervision of sending DSPs: The sending DSPs are marked valid by the Processor Module via BIOB; if the DSP on the AF 100 bus coupler CI630 isn‘t marked any longer the transmission via AF 100 is stopped by the coupler; as a result the receiving AF 100 bus coupler recognizes the missing DSP and marks it invalid which is visible for the application program • In redundancy-mode the 7-segment display on the Processor Module supports two new codes: – b1 = application program on slave Processor Module is running – bF = slave Processor Module not ready for redundancy switch over, for example failed without HALT or STOP Further improvement: • Increase the retries for BIOB accesses from 10 to 100
1.0/2	No functional changes.
1.0/3	No functional changes.
1.0/4	No functional changes.
1.0/5	No functional changes.
1.0/6	No functional changes.

Table 1-2. Release History (Continued)

Version	Description
1.1/0	The new added functions are: • PM644 Processor Module with build-in PROFIBUS-DP interface • S800 remote I/O, connected via a subordinated, redundant Advant Fieldbus 100 • CI627/CI631 Advant Fieldbus 100 Communication Interfaces for twisted pair bus cables • Communication Interface redundancy for the subordinate Advant Fieldbus 100 (CI630 for coaxial bus cables, CI631 for twisted pair bus cables) • DI685 digital input module with sequence of event capability, wire break supervision and onboard sensor power supply • Optional program module OPT11, for correcting of measurement values • Year 2000 compliant
1.1/1	No functional changes.
1.1/2	No functional changes.
1.1/3	No functional changes.
1.1/4	No functional changes.

Table 1-2. Release History (Continued)

Version	Description
1.2/0	The new added functions are: • Password protection for tool access to controller. • PM646 Processor Module with additional hardware and software monitoring functions required for safety application systems. • AX646 analog input module with tested input channels. • DX610 relay output module with tested output channels. • Update slave in CPU redundancy with the application program of the master via “ACK”-push button. • New S800 remote I/O modules: - DI885 digital input module with sequence of event capability - CI820 redundant field Communication Interface (FCI) - DO815 digital output module, 2 Amp current sourcing outputs - DO821 digital output module, 230 V AC/DC relay, normally closed outputs • MODBUS interface on Processor Modules with extended supervision, error handling and variable node address. • Time synchronization with external clock via minute pulse input for PM645 and PM646 Processor Modules. • Option OPT6 for station redundancy and rotational speed measurement (PC elements moved from OPT12 to OPT6). The removed functions are: • OPT10 and OPT11 not longer part of the general AC 160 software. The options are power plant specific and can therefore be ordered separately by: ABB Utility Automation GmbH P.O. Box 10 03 51 D–68128 Mannheim Phone: +49 / 621 381 6544, Fax: +49 / 621 381 4372

Table 1-2. Release History (Continued)

Version	Description
2.0/0	The new added functions are: • 4× Advant Fieldbus 100 connections per Basic Station. • SERCOS interface. • Enhanced PROFIBUS support: – PROFIBUS Library Editor (PLE) for configuration including GSD import – Dynamic data access via DB Elements – Real format for AI/AO values. • CONTRM can be triggered by the Processor Module's onboard I/O. • PC Element PID (PID-algorithm) added. • DCF77 support via second serial interface (Com B). • Support for CI830 (S800 connected as PROFIBUS I/O).

1.6.3 Differences Advant Controller 160/Advant Controller 110

Advant Controller 160 provides increased performance and a variety of additional functions in comparison with Advant Controller 110. Additionally some specific rules for configuration and system handling must be observed. These differences are listed below in Table 1-3.

Table 1-3. Differences between Advant Controller 160 and Advant Controller 110

Characteristics	Advant Controller 160	Advant Controller 110
Redundant Processor Modules	Yes	No
Multiprocessing with up to 6 Processor Modules	Yes	No
High speed data communication between Processor Modules	Yes	No
Multimaster backplane	Yes, specific slot assignment rules	No
Number of Advant Fieldbus 100 Interfaces	4	1
Use of Communication Interface CI626 or CI630 for main Advant Fieldbus 100	Mandatory for system	Yes, CI626 only
Use of Communication Interface CI627 or CI631 for subordinate Advant Fieldbus 100	Yes	Yes, CI627 only
Redundant Advant Fieldbus 100 Communication Interface	Yes (CI630, CI631), for controllers with redundant CI630, CI631 only AF 100 station addresses 1 to 47 are allowed	No
Redundant I/O extension with CI615 and CI610	Yes	No
Termination of unused supervised AI channels	Needed to satisfy internal diagnostics	Not needed
Output set to predetermined in case of system failure	No. You may use relay output on the Processor Module to switch off the external supply voltage	Yes

Table 1-3. Differences between Advant Controller 160 and Advant Controller 110 (Continued)

Characteristics	Advant Controller 160	Advant Controller 110
PC elements for sequence control	SEQ + STEP only for non redundant processing. GRC + P_STEP must be used for redundant processing	SEQ + STEP
Support for SC610, one SC610 per controller	Yes, one non redundant Processor Module or one redundant Processor Module with station redundancy can communicate with SC610, multiprocessing possible in parallel	Yes
RCOM interface on front plate of the Processor Module	No	Yes
Support for Master Fieldbus	No	Yes
Warm start of Processor Module	No	Yes
Tool access via Processor Module's front connector to other Processor Modules	Only to Processor Modules within other stations	Yes
Support by Engineering Station AS 500ES	No	Yes

1.7 Terminology

The following is a list of terms associated with Advant Controller 160 that you should be familiar with.

Term	Description
AC 110	**A**dvant **C**ontroller **110**
AC 160	**A**dvant **C**ontroller **160**
AF 100	**A**dvant **F**ieldbus **100**
AMPL	The **A**BB **M**aster **P**rogramming **L**anguage is used for application programming.
Application Program	An application program is a general concept of an assembly of program functions aimed at realizing and automating an addressed process control function.
Application (user-built)	An application is a user-implemented configuration of standard hardware and software units. It is the solution to the user's problem.
AS 100ES	**A**dvant **S**tation **100** Series **E**ngineering **S**tation
Backplane	A backplane is part of a subrack which interconnects inserted electronics *modules* with the help of a communication bus.
Base Station	The station housing the Processor Modules within its basic subrack is called the base station.
Basic Subrack	The first subrack of a base station or an I/O station is called basic subrack.
Basic System	Basic system is the abstract name of a minimal composition of functional units forming a system.
Basic Unit	Basic unit is used for ordering purposes (for example, in the Price Book) as a name for the smallest unit to be ordered or a platform for further enlargement with alternatives and options.
BIOB	The **B**ackplane **I/O B**us of Advant Controller 160.
Cabinet	The cabinet is the outer case of a piece of equipment (a packaging option), for example, Controller cabinet, I/O cabinet.
CE marking	CE = Communaute European = European Community CE marking certifies that the product keeps the respective EC directives.
CI	**C**ommunication **I**nterface.
CPU, Central **P**rocessing **U**nit	A CPU is a functional unit consisting primarily of a microprocessor and memory. Located in a Processor Module.

Term	Description
Circuit Breaker	In the context of a process control system, a circuit breaker is a device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined-ed overload of current, without injury to itself.
Cold Start	Cold start resets hardware and software of a *Processor Module* to their initial states. In case of Advant Controller 160 application software is loaded from the internal PROM to RAM of the CPU.
Communication Interface Modules	Modules used in Advant Controller 160 for communication with I/O or other stations.
Controller	Controller is a descriptive name for Advant Controller products. A controller is an entity in which control applications are running. From the product viewpoint, a controller consists of one or more *CPU*s, communication and certain auxiliary equipment such as power supply. It also includes the functionality of process I/O (the process data communication software). It does not include process I/O hardware (and firmware as applicable). C.f., *Process station, Station*.
DB element	Data Base element.
DPM	**D**istributed **P**eripheral **M**odule. In this manual the term PROFIBUS slave is used instead.
Engineering Station	In the following chapters this term is used as abbreviation for Advant Station 100 Series Engineering Station.
ESD	**ESD** stands for **E**lectro**S**tatic **D**ischarge.
Executable Unit	Modular part of the PC part of the application program with own cycle time.
Extension subrack	A base station and an I/O station can be expanded by a second subrack. This second subrack is called extension subrack.
HSL	**H**igh **s**peed **s**erial **l**ink Link between Processor Modules via on-board interfaces.
I/O	I/O is process **I**nput or **O**utput. From the functional and geographical distribution viewpoint, process I/O is distinguished into two main categories: - central (located close to the controller) - distributed (in the process environment).
I/O station	A station connected to the base station via an I/O extension bus housing I/O modules.

Term	**Description**
IMS, Information **M**anagement **S**tation	An IMS is a station executing information management applications such as statistical control, production control, and so on.
Initialization	Initialization sets a starting position.
LED	**L**ight **E**mitting **D**iode.
Local Control, local operator	Local control is a mode of operation where responsibility is assigned to an operator/equipment located in the process environment close to the process object.
Module	A module is a hardware unit, with or without accommodated software, or a software unit. There are modules of various sizes and functionality. Examples of hardware modules: *Subrack, submodule carrier*, communication module, I/O module. Examples of software modules: Basic system program module in a controller, a PC element.
Multi-drop Connection	A multi-drop connection is a means of establishing a multi-drop network, that is, a network with two endpoint *nodes*, any number of intermediate *nodes* and only a single path between any two *nodes*.
Multimaster backplane	*Backplane* of the *basic subrack* of the *basic station* supporting *multiprocessing.*
Multiprocessing	Processing of multiple *Processor Modules* in parallel within a *controller.*
Node	A node in general: A point in a data network. A node in an application: 1. Any logically addressable unit directly connected to the plant or *control network*. Examples are controller, process station, operator station. 2. Any logically addressable unit connected via RCOM.
Off-line	With off-line configuration, configuration data is created outside the application for later installation, or the internal configuration data is directly affected, but the application is inactive.
On-line	With on-line configuration, the internal configuration data of a system application is directly affected, while the application is active.
PC element	“Function Block” in AMPL.
PC program	Process Control program
PE	Protective Earth

Term	Description
PM	**P**rocessor **M**odule
Position	Position means: 1. The place in the subrack where you put a *module*. 2. The place in a *submodule carrier* where you put a submodule (submodule position).
ppb	Parts per billion
Process Object	A process object is process concept/equipment, for example, valve, motor, conveyor, tank.
Processor Module	Module within an Advant Controller for processing of the control application program, see also *CPU.*
Process Station	Process Station is a descriptive name for Advant products. A process station is an entity in which control applications are running. It includes the process I/O, confer *controller.*
PROFIBUS-DP	Process Fieldbus - Decentralized Periphery PROFIBUS-DP protocol whose speciality is high-speed, cyclic data communication
RAM	**R**andom **A**ccess **M**emory
Redundancy	Redundancy in general means the existence of more than one capability of an item (system, apparatus, component) to perform its intended function.
Re(start)	Phases of the re(start) process include, for example, power-up diagnostics and node initialization. In case of Advant Controller 160 during the initialization phase a *cold start* is performed depending on START MODE selector of the CPU.
Station	Station is a descriptive name for Advant Station products. Station can also be used instead of *Process Station* or *Controller*.
Submodule Carrier	A submodule carrier is a module (circuit board) which houses smaller *modules* (submodules).
Subrack	According to IEC 916, subracks (equipment frames) are the mechanics which house rows of modules. Different types of subracks are available, for example, controller subrack, I/O subrack.

Term	Description
Type Circuit	Type circuit is an application-specific standard solution for process control problems in case of controller configuration. The scope of a type circuit is the data base and the PC program.
Typical Solution	A typical solution is a reusable module, which is a predefined, tested and documented set of formal configuration data intended to provide a standardized solution to a frequently recurring problem. It covers all data within the engineering system. The scope of a typical solution is drawings, documents, devices, configurating data for the distributed control system, such as data base and PC programs, operator's interface, and so on.

1.8 Product Overview

Advant Controller 160 is a modular controller for logic and regulatory control.

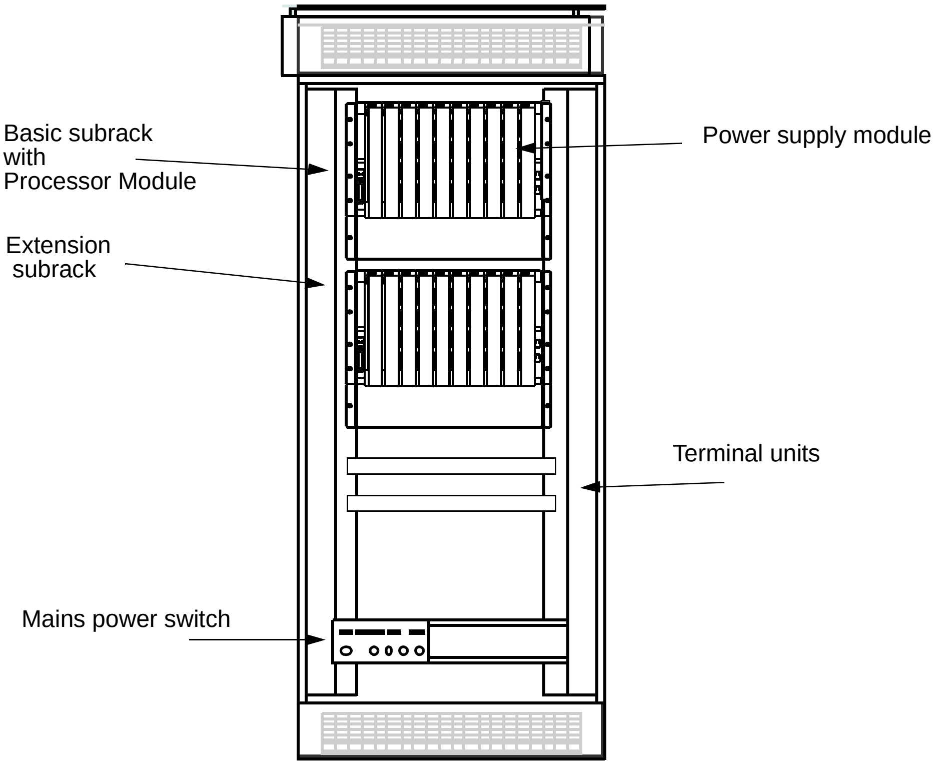


Figure 1-4. Advant Controller 160, Example of Physical Appearance

The system can handle up to 1500 inputs and outputs. Interfaces are available to other vendors' systems.

Measured values can be tied to event registration.

Depending on the number of input and output channels, an Advant Controller 160 system consists of one base station with one or two subracks (equipment frames) and optionally up to seven I/O stations, each with one or two subracks (see examples shown in Figure 1-5). These stations are installed in one or several cabinets.

You can include Advant Controller 160 in a network with products of the Advant OCS System, for example other Advant Controllers and products from Advant Station 100 Series (see Figure 1-1). These products include operator stations, information management systems (IMS) and Engineering Stations.

You can connect a local or central operator station or a local operator panel to an Advant Controller 160 (see Section 1.8.7, Operator Interface).

The programmability of Advant Controller 160 covers a wide range of functions, such as logic and sequence control, data handling, arithmetic, and regulatory control (see Section 1.8.2.2, Functions of BASE System Software).

A function-block language with graphic representation, AMPL (ABB Master Programming Language), is used for configuration and application building. It is especially oriented toward process control (Section 1.8.6, Process Control).

Program entry, testing, documentation and fault tracing are supported by Advant Station 100 Series Engineering Station. These stations feature graphical Windows based function-chart programming and a user interface with multiple windows, pull down menus and "point-and-click" selection. Advant Controller 160 communicates with the Engineering Station through a standard serial interface. If the target node for the Engineering Station is a member of an Advant Fieldbus 100 network the Engineering Station is able to access all other stations on the network from that single connection. It is further possible to connect an Advant Station 100 Series Engineering Station to an Advant Controller 400 Series station and go from there with an RCOM connection to Advant Controller 100 station.

1.8.1 Product Structure

1.8.1.1 General Modularization

Advant OCS is a totally modularized system at all levels. Seen from a high level Advant OCS consists of a family of system products. An example of an Advant OCS system applying system products is illustrated in Figure 1-1.

The functional extent of Advant Controller 160 system is determined by adding optional software and hardware units to the basic unit. The software options are delivered as program modules and may be selected to create the desired functional configuration. Optional hardware units are I/O and communication modules, and so on.

1.8.1.2 Hardware

A Basic Unit Advant Controller 160 comprises the parts listed in Table 1-4.

Table 1-4. Basic Unit for Advant Controller 160

Units	Description
PM640/PM644/PM645A/ PM645B/PM645C/PM646	Processor Module
RF616	Subrack
RC610	Cable duct
BASE incl. OPT2, OPT3 (1)	Basic system software incl. program modules 2 and 3 on 3.5″ diskette.

(1) for PM640, PM644, PM645A, PM645B, PM645C, PM646

You can extent a Basic Unit to an Advant Controller 160 system that includes:

- Processor Modules with CPU and memory residing the fixed internal program (the system software) and the application program
- Process I/O modules
- Power supply modules
- Communication modules
- Communication submodules
- Submodule carrier.

The process I/O is described in separate I/O documentations (see *S600 I/O Hardware Reference Manual, S600 I/O Hardware Advant Controller 160,* and *S800 Users's Guide*). This means that, in this manual, you will find only short presentations of supported I/O systems and I/O modules.

Processor Module, power supply module, communication modules and submodule carrier are installed in a subrack. Free slots in the subrack may be used for S600 I/O modules. Additional I/O modules can be installed in a second subrack or in separate I/O stations. Figure 1-5 shows an example of an Advant Controller 160 system structure with 2 base stations and 1 I/O station.

1.8.1.3 Software

When you order Advant Controller 160, you select the desired function repertoire from several software options. These software options are delivered on diskette, which can be loaded into the flash PROM of the Processor Module using Advant Station 100 Series Engineering Station.

- Basic system software functions:
  - BASE: Base system software
  - OPT2: MVI support for SC610 and CI532
  - OPT3: Event handling
  - Option LONG: Enables longer BIOB time-out
- Additional system software functions:
  - OPT1: Extended PC Element Set
  - OPT4: MODBUS I protocol (support for local Operator Station or panel)
  - OPT6: Station redundancy and rotational speed measurement

1.8.1.4 Example of Advant Controller 160 System Structure

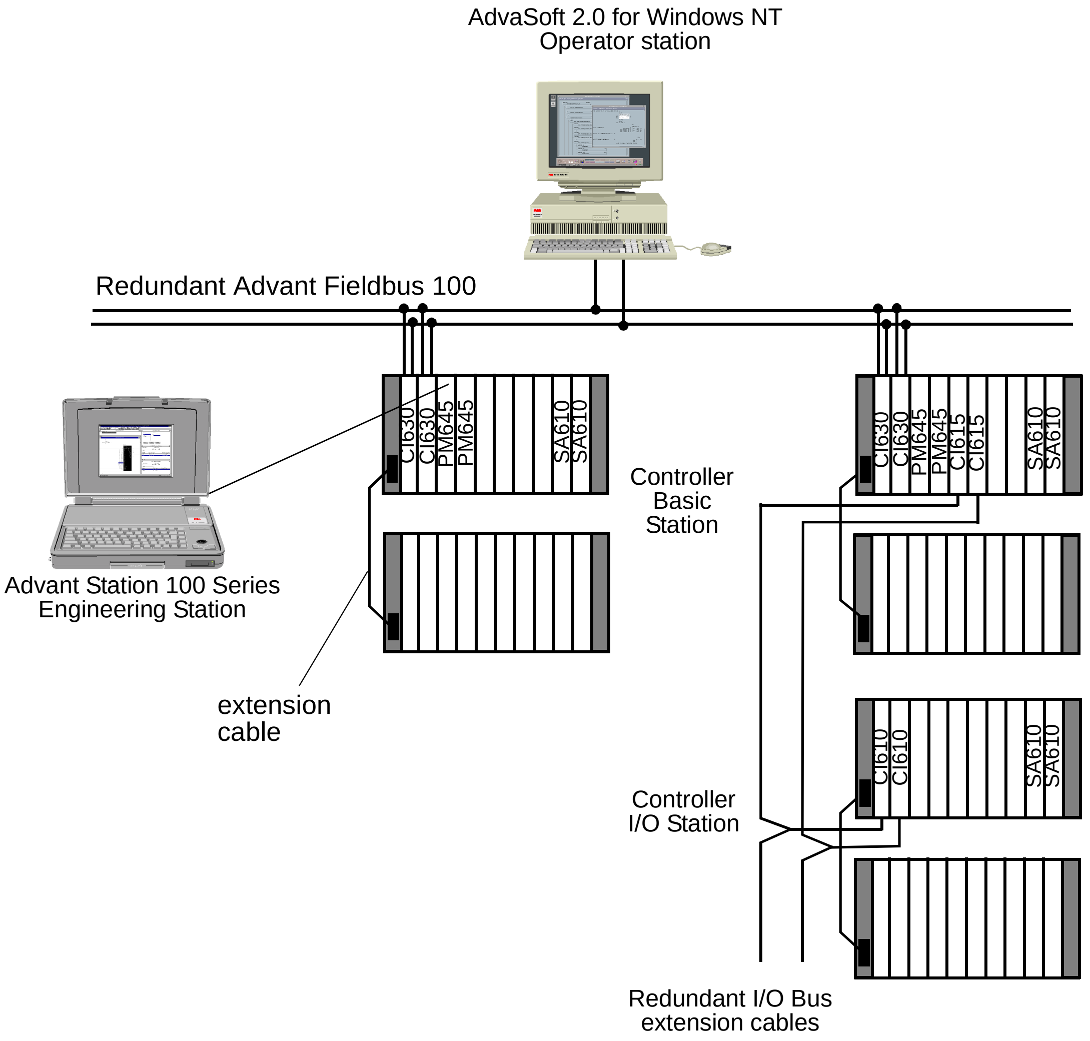


Figure 1-5. Advant Controller 160 System Structure (Redundant Configuration)

1.8.2 General System Utilities

1.8.2.1 Processor Modules

Processor Module PM640

- The Processor Module PM640 contains a Motorola MC68360 processor, 1 Mbytes non-volatile memory (Flash PROM) for the user built application and 2 Mbyte nonvolatile memory (Flash PROM) for the system software and 2 MBytes SRAM. At start-up the application is copied from the nonvolatile memory into 2 Mbytes SRAM memory where it is executed. The memory is not expandable.
- PM640 contains two RS232-C ports dedicated for connection of Advant Station 100 Series Engineering Stations and for connecting an local PC based operator station via MODBUS protocol.

Processor Module PM644

- The Processor Module PM644 has all features of PM640 as described above and in addition the following ones:
- The Processor Module PM644 additionally contains a second Motorola MC68360 processor with extra 2 MByte nonvolatile memory (Flash PROM) for the system software and extra 2.25 Mbyte SRAM for the PROFIBUS communication.
- The Processor Modules PM644 contains a PROFIBUS-DP master interface with RS485 port for data exchange via PROFIBUS.
- The PM644 additionally contains two rotational speed signal input ports RS422.

Processor Module PM645 of type A, B, or C

- The Processor Modules PM645 have all features of PM640 as described above and in addition the following ones:
- All Processor Modules PM645 additionally contain a second Motorola MC68360 processor with extra 512 kbyte nonvolatile memory (Flash PROM) for the system software and extra 2 Mbyte SRAM.
- All Processor Modules PM645 contain two RS422 ports (high speed serial links) for signal and data exchange between Processor Modules for application and system purposes.
- The Processor Modules PM645A and B additionally contain a redundancy voter for dual and triple redundancy.
- The PM645B and C additionally contain two rotational speed signal input ports RS422.

Processor Module PM646

- The Processor Module PM646 has all features of PM640 as described above and in addition the following ones:
- The 2 Mbytes SRAM is extended with a secondary 2 Mbytes SRAM (Mirror-RAM) for a redundant data storage with a hardware-based data comparison

- The Processor Module PM646 additionally contains a second Motorola MC68360 processor with extra 2 MByte nonvolatile memory (Flash PROM) for the system software and extra 2 Mbyte SRAM.
- The Processor Module PM646 contains two RS422 ports (high speed serial links) for signal and data exchange between Processor Modules for application and system purposes.
- The Processor Module PM646 additionally contains a redundancy voter for dual and triple redundancy.
- Both processor boards of PM646 each contain a watchdog circuit with outputs combined for triggering the on-board relay (Implementation of an independent "Second Shutdown Path" for safety systems)
- Extended 5 V-power supply supervision with under- and overvoltage detection.

All Processor Modules PM640, PM644, PM645A, PM645B, PM645C and PM646 include a real-time clock and calendar.

NOTE

At least one Communication Interface CI626 or CI630 is mandatory even if no Advant Fieldbus 100 communication is required. CI626 or CI630 is needed for controller internal data management tasks.

Indicators

On the module front of each CPU you can see indicators and a character display for high level system diagnostics. Faults are indicated on this diagnostic display and by a relay contact.
You can obtain more detailed diagnostic information by connecting Advant Station 100 Series Engineering Station to the central processing unit.

Start-Mode

A four-position rotary switch with two used positions allows the selection of the start mode. See Section 4.3.3, Start Modes for more information on these functions.

Serial Interfaces

There are two serial interfaces on each central processing unit:

- The first one is used to connect Advant Station 100 Series Engineering Station.
- The second one is used for exchanging data using the Modbus (RTU) protocol with an operator station based on a personal computer or flat panel display.

Link 1 and Link 2 Connections

The Processor Modules PM645 and PM646 contain communication links **Link 1** and **Link 2** for redundancy, for protection or for general signal exchange.

- The receive and transmit channels are serial RS422 channels with HDLC protocol, the speed is 3.1 MBaud on each channel.

I/O Connection

The Processor Module PM645 and PM646 contain a digital input/output interface for 24 VDC digital inputs and 100 mA digital outputs. The output stages are monitored and short circuit protected.

All I/O are predefined and reserved for redundancy and minute pulse connection.

PROFIBUS Connection

The Processor Module PM644 contains a PROFIBUS-DP interface according to EN 50170.

Rotational Speed Connection

The Processor Modules PM644 and PM645 contains two incremental inputs with speed measurement and recognition of the direction of the rotation (for example for turbine/drive speed). Each channel includes two RS422 tracks (A and B) for connection of a pulse sensor. The direction of the speed measurement is identified through the phase displacement. Synchronization is not supported.

Memory

The Processor Modules PM640, PM644, PM645 and PM646 are supplied completely with a built-in memory. No extra memory modules are required or can be added. The system software flash PROM holds the controller system software and provides all memory executed in run time. The user flash PROM holds the controller system configuration and application program which is loaded to the RAM at system start.

The Processor Module PM644 consists of two hardware sections, the processing section PS with microprocessor and memory for the application program and the communication section CS with separate microprocessor and memory for the PROFIBUS signal exchange.

The Processor Modules PM645 and PM646 consist of two hardware sections, the processing section PS with microprocessor and memory for the application program and the communication section CS with separate microprocessor and memory for the communication needed for redundancy and signal exchange for protection and general control applications.

Table 1-5. CPU Memory

CPU type	RAM	User Flash PROM	System Flash PROM
PM640	2 Mbyte	1 Mbyte	2 Mbyte

Table 1-5. CPU Memory (Continued)

CPU type	RAM	User Flash PROM	System Flash PROM
PM644			
processing section (PS)	2 Mbyte	1 Mbyte	2 Mbyte
communication section (CS)	2.25 Mbyte	no user Flash PROM	2 Mbyte
PM645 and PM646			
processing section (PS)	2 Mbyte	1 Mbyte	2 Mbyte
communication section (CS)	2 Mbyte	no user Flash PROM	512 Kbyte

1.8.2.2 Functions of BASE System Software

BASE System Software

The Advant Controller 160 BASE system software includes a real-time operating system, a PC element library, diagnostic functions and interfaces for Advant Station 100 Series Engineering Station and AdvaSoft for Windows or AdvaSoft 2.0 for Windows NT.

The application program consists of one AMPL program, that is one PCPGM, and up to 31 subordinate executable units (CONTRM, SEQ or MASTER). These are executed cyclically with execution times selectable from 2 msec to 20 sec. It is also possible to define subordinate executable units (CONTRM) that are executed once at cold start. The start-up sequence can be defined by the user.

Diagnostic functions monitor system operation and report any faults detected. The monitoring functions include a watchdog, bus supervision and memory checking. Faults are indicated on the diagnostic display on the front of the unit. More detailed diagnostic information can be obtained with an Advant Station 100 Series Engineering Station.

Communication functions via Advant Fieldbus 100 are included.

The basic system program is sufficient when you need digital signal processing and basic arithmetic, regulatory and logic functions. It works with both analog and digital input and output signals.

The basic program module has a functional content in accordance with:

- Logic control and time delays
- Arithmetic
- Sequence control
- Calendar time functions
- Connection to Advant Controller 400 Series
- Redundancy and multiprocessing
- CPU load measurement

- Advant Fieldbus 100 communication
- High speed link communication
- PROFIBUS communication
- Protection system monitoring functions

Most of the above mentioned functions are realized with one or several AMPL elements. The contents of the PC element library in the basic program module is shown in Table 1-6.

Table 1-6. PC Elements of the BASE System Software

Type	Function	PC Element
Structure elements	Structuring the PC program and sequential control.	PCPGM, CONTRM, FUNCM, MASTER, SLAVEM, BLOCK, SEQ(1), STEP(1), GRC, P_STEP
Logic	Combinational logic and Boolean memory.	AND, OR, XOR, INV, AND-TRG, OR-TRG, ADD-MR, TRESH-L, SR, SR-D, SR-AA, SR-AO, SR-OA, SR-OO, AND-O, OR-A, BGET, BSET
Time	Timer for on- and off-delays, pulse functions, oscillator and calendar timing.	MONO, MONO-UT, TON, TOFF, TON-RET, TRIGG, OSC-B, TIMER, SYSTIME
Register	Shift and queue register.	FIFO, MOVE, REG, SHIFT
Switches	Switching sets of data.	SW, SW-C
Multiplexer	Select data from a group of data.	MUX-I, MUX-MI, MUX-MN
Code converter	Convert data from one type to another, for example, Boolean to integer.	CONV, CONV-BI, CONV-IB
Counter	Pulse counting.	COUNT
Arithmetic	Basic arithmetic operations and square root, absolute value and limit functions.	ADD, SUB, MUL, DIV, ABS, SQRT, LIM-N,DIV-MR, MULDIV
Comparators	Comparison of two numbers, limit value monitoring and maximum or minimum selection.	COMP-I, COMP-R, COMP-B, MAX, MIN

Table 1-6. PC Elements of the BASE System Software (Continued)

Type	Function	PC Element
Redundancy	Tracking of historical values and redundancy status handling.	MOVERED, RED-STAT
PROFIBUS	Communication via PROFIBUS-DP.	PB-IN, PB-OUT
Protection	Providing analog/binary measured values including test functions Providing binary output values including test functions CRC-comparison between parallel protection controllers.	PC_AX646 CONV_AX PC_DX610 SYS_CRC
Miscellaneous	Evaluate the load of an Advant Controller 160 system.	SYSL

(1) SEQ and STEP cannot be used with redundant processing (CPU or station redundancy). Instead GRC and P_STEP can be used.

Program Module, OPT2 SW

The program module OPT2 is already included within the BASE system software.

In conjunction with the MVI module CI532 V01, V02 or V03 the software option 2 (MVI Handling) extends the functionality of the controller with the following communication facilities:

- RCOM/RCOM+
- Siemens 3964(R)
- MODBUS

Program Module, OPT3 SW

The program module OPT3 is already included within the BASE system software.

The software option 3 (Event Handling) extends the functionality of the controller with event handling:

- Detection of calculated events of digital or analog signals.
- Handling of events from modules DI650 and DI685.
- Event handling and event transfer via AF 100.
- Event handling via RCOM/RCOM+ (requires also OPT2 software).
- Time tagging of events
- Transit of events.

1.8.2.3 Software Option OPT1, Extended PC Element Set

Software option OPT1 extends the PC element library that is included in the basic program module with PC elements for supporting regulatory control. The PC elements in OPT1 are shown in the table below.

Table 1-7. PC Elements of the Option OPT1 Extended PC Element Set

Type	Function	PC Element
Register	Register for assembling single data with a group data.	REG-G, REG-G-UT
Function generator	Generates an output from an input variable according to a function described by a group data table.	FUNG-1V
Filter	Single-pole low-pass filter.	FILT-1P
Regulatory/ feedback control	Various P, I, and D functions and combinations thereof, a pulsed regulator and a ramp generator.	P-1, INT, DER, PI, PID, PIP, PDP, CON-PU1, RAMP

1.8.2.4 Software Option OPT4, MODBUS I Protocol

The Optional program module OPT4, Modbus I Protocol extends the functionality of the controller with the MODBUS protocol (RTU, binary mode), which is intended for communication with a PC based HMI package.
The separate serial interface (**Com B** connector) on the Processor Modules is used for this purpose.

1.8.2.5 Software Option OPT6, Station Red. + RSM

The optional program module OPT6, Station Red. + RSM extends the PC element library that is included in the basic program module with PC elements for supporting the functions described below:

- Station redundancy.
- Rotational speed measurement.

For redundant configurations with two or three redundant Processor Modules within separate stations (station redundancy) the optional program OPT6 is necessary.

The contents of the PC element library in OPT6 are shown in Table 1-8.

Table 1-8. PC Elements in the Program Module OPT6

Type	PC Element
Measurement elements	RSM

Table 1-8. PC Elements in the Program Module OPT6 (Continued)

Type	PC Element
Signal Selector	MOON
Redundancy	TRAC, SW-RED

1.8.2.6 System Clock Synchronization

The Processor Modules PM640, PM644, PM645 and PM646 are provided with a calendar clock. You can set the date and time from Advant Station 100 Series Engineering Station or from AdvaSoft for Windows.

With Advant Controller 160 connected to Advant Fieldbus 100, as a part in a distributed control system, the synchronization occurs automatically with other stations via a network. One station of the AF 100 network is time synchronization master sending the time to all other stations.

The Processor Modules PM645 and PM646 can be synchronized by an external clock (minute pulse) which can be directly connected to these modules.

In case of missing synchronization the internal clocks of the controllers and stations provide the actual time with reduced accuracy.

1.8.2.7 Configuration

You configure the system in accordance with the hardware and software selected, for example, the number of I/O modules, communication lines, and PC programs. This is performed using a configuration tool such as Advant Station 100 Series Engineering Station.

1.8.2.8 Execution

The system software (operating system and PC interpreter) organizes the execution of the units of the application program with the periodicity selected, simultaneously performing other tasks such as communication with programming tools or with other Advant Controller 160 using Advant Fieldbus 100 or other protocols (see also Section 1.8.2.2, Functions of BASE System Software).

1.8.3 Power Supply

Advant Controller 160 with S600 I/O can be connected to the following types of primary supply:

- 120 V or 230 V a.c., 47 to 450 Hz, using the power supply module SA610.
- 110 V/125 V or 220 V/250 V d.c., using the power supply module SA610.
- 24 V d.c. filtered voltage, direct supply to the I/O station from an external power supply. The acceptable voltage range is 19.2 – 30 V d.c. SA 161 or SA 162 can be used as an external power supply.

The use of the power supply module SA610 is recommended. SA610 is housed in the standard module enclosure and occupies one position in the subrack.

Dependent on the needed power and required redundancy 1 to 4 power supply modules SA610 can be applied per Basic or I/O station.

In addition, you can find more detailed hardware descriptions of SA610 in the *S600 I/O Hardware Reference Manual.*

1.8.4 Process Interface

1.8.4.1 S600 I/O

The I/O system of Advant Controller, S600 I/O is used as local I/O system close to the controller, in the controller subrack or cabinet.

A range of I/O modules is available, covering analog and digital signals of various types. In addition, there are modules for temperature measurement, pulse counting and position measurement applications. The process signals are connected to the front of the I/O modules.

The S600 I/O is modular and may consist of up to 75 I/O modules. The maximum number of I/O signals for an Advant Controller 160 is 1,500.

I/O modules may be exchanged during system operation. The process signals are disconnected by removing the front connector. A newly inserted module is automatically put into operation if the system identifies the module as being of the correct type and without faults. I/O stations may be added to further extend the number of I/O modules connected to the system.

The *S600 I/O Hardware Reference Manual* lists the details of the various S600 I/O modules available for Advant Controller 100 Series, whereas the *S600 I/O Hardware Advant Controller 160 Reference Manual* describes the additional modules available only for Advant Controller 160.

1.8.4.2 S800 I/O

For applications requiring the use of *remote I/O*, S800 I/O modules may be connected over Advant Fieldbus 100. These modules cover analog and digital signals of various types.

The *S800 User's Guide* gives details about these modules. A detailed list of S800 modules supported by Advant Controller 160 can be found in the *Advant Controller 160 Product Guide.*

1.8.5 Communication

Various buses and links in accordance with Table 1-9 can be connected to Advant Controller 160.

Table 1-9. Number of Buses and Links that can be connected to Advant Controller 160

Bus/Link Type	Max Number	
Advant Fieldbus 100	max. 4 buses	
High Speed Serial Link via Processor Module PM645 and PM646	max. 2	Total max 12
Bus extension to S600 I/O	max. 1 bus	
PROFIBUS-DP via Processor Module PM644	max. 6 buses	
MODBUS (slave function) via second serial interface at Processor Module	max. 1 link	
RCOM via submodule CI532	max. 4 links (master) max. 2 links (slave)	Total max. 4 (master) Total max. 2 (slave)
MODBUS via submodule CI532	max. 4 links (master) max. 2 links (slave)	
SIEMENS 3964R via submodule CI532	max. 4 links (master) max. 2 links (slave)	

1.8.6 Process Control

1.8.6.1 Programming Language

Process control applications are programmed in the ABB Master Programming Language (AMPL), a function-block language with graphic representation which has been developed especially for process control applications. The language is characterized in this way: each function is seen as a building block with inputs and outputs. The function of such a block can be simple, such as a logic AND function, or complex, such as a complete PID regulator. A program written in AMPL is referred to as a PC (process control) program, and the building blocks are called PC elements. The range of ready-to-use function blocks is wide and powerful.

The smallest units in the language are standardized functions, represented by graphic symbols (PC elements). Each PC element represents a complete function such as an AND-gate, a time delay, a shift register, a PI function, and so on (see Figure 1-6). The language offers a simple method to link PC elements and describe the data exchange between the functions selected to control the process.

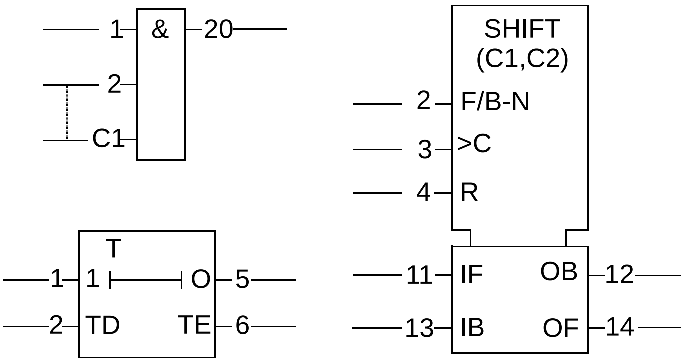


Figure 1-6. Example of PC Elements (AND, TON, SHIFT)

You can assemble a number of PC elements to form a PC module, which in turn can be incorporated in further modules. Several modules form a PC program, which is the solution to automate a specific process control function. Such a PC program executes the PC modules, element by element, with a cyclicity which you can select from 2 ms up to 20 s.

Data base elements (DB elements) are used for exchanging data with the I/O-system and with other parts of the Advant OCS system.

For information about AMPL, see *AMPL Configuration Advant Controller 100 Series, Reference Manual.*

1.8.6.2 On-line Features

Advant Controller 160 provides a wide range of on-line features:

- On-line configuration and programming:
  On-line configuration and programming is the modification of a user application program on an Engineering Station while the Engineering Station is connected to an Advant Controller 160 system. Modification in this case includes insertion and deletion of executable units and insertion of DB elements. The modification of a running application program is bumpless and remains after disconnecting the Engineering Station.
- Value display and value forcing
  - PC terminal value display and forcing:
    Value display (monitoring) and forcing of PC terminals are parts of the test functions of the Engineering Station. During forcing of values the Engineering Station has to be connected to an Advant Controller 160 system. Advant Controller 100 system stops forcing when the Engineering Station is disconnected.
  - DB terminal value display and forcing:
    Value display (monitoring) and forcing of DB terminals are parts of the test functions of the Engineering Station. Once forced DB terminals remain forced also if the Engineering Station is disconnected. Forcing of DB terminal is permanent and must be undone by the engineer via the Engineering Station.

For more information see *AMPL Configuration Advant Controller 100 Series, Reference Manual and AdvaBuild for Windows Function Chart Builder User’s Guide.*

NOTE

In contrast to Advant Controller 70 and 110 on-line deletion of DB elements is not supported by Advant Controller 160.

1.8.7 Operator Interface

Advant Controller 160 offers a range of different interfaces to operators. A short presentation is given below. For detailed information, see separate documentation.

1.8.7.1 Maintenance Personnel

The main purpose of this type of interface is to support fault tracing and backup handling of an application program. There are:

- Start MODE selector, LED indicators and character display on the Processor Module.
- Diagnostics LED indicators on most hardware modules.
- Advant Station 100 Series Engineering Station provides menus for error report and module diagnostic.

1.8.7.2 Local Operator

Panel

Panel units, for example, numeric display, keyboard, function keyboard, push button and thumbwheel may be connected via Modbus protocol to the second serial interface (Com B) of the Processor Modules. Push-buttons and lamps can also be connected via S600 I/O modules.

For more information about connecting a panel, see *MODBUS Panel Connections Advant Controller 100 Series, User’s Guide*.

Local Operator Station

You can connect a PC-based operator station to Advant Controller 160 via Modbus protocol to the second serial interface (Com B) of the Processor Modules.

1.8.7.3 Central Operator

You can use the AdvaSoft for Windows as PC-based central operator station for Advant Controller 160 systems connected via Advant Fieldbus 100 or Advasoft 2.0 for Windows NT connected via AF 100 OPC Server.

For information about AdvaSoft, see *AdvaSoft for Windows, User’s Guide.*

1.8.8 Mechanics

Mechanically Advant Controller 160 consists of subracks, cable ducts, modules and process connectors. The subracks and cable duct are designed for wall mounting. For more information see Section 2.2.14, S600 I/O. Figure 1-7 shows the physical layout of a basic and extension subrack. Advant Controller 160 can be delivered as separate subracks for mounting in any suitable cabinet too. It can also be delivered in standard cabinets.

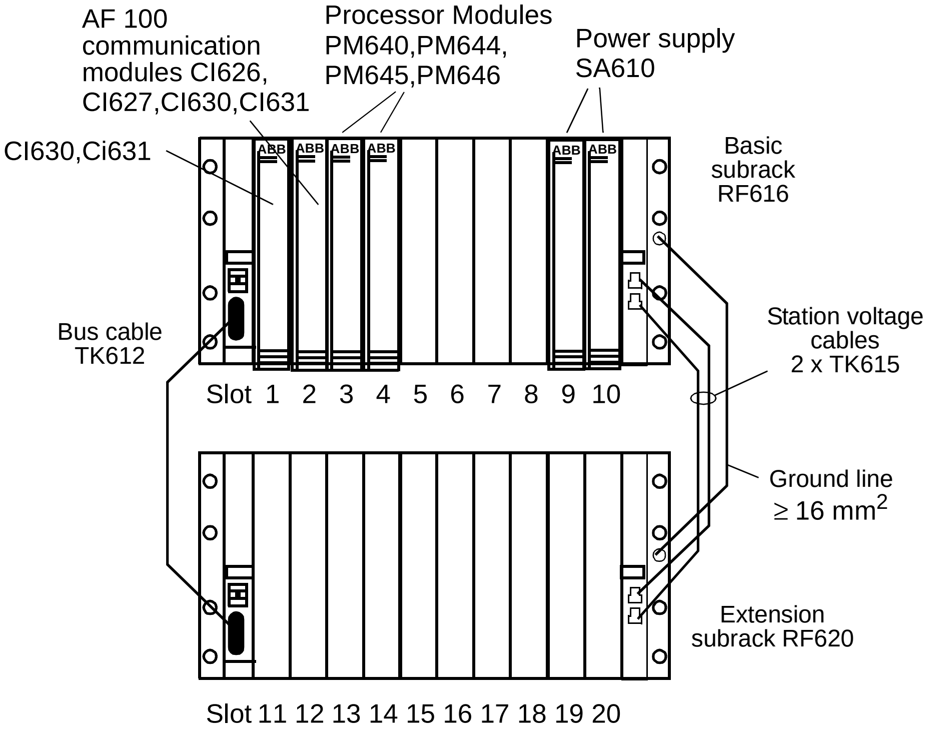


Figure 1-7. An Advant Controller 160 Configuration

Chapter 2 Installation

This chapter contains guidelines for planning the installation of your Advant Controller system, see Section 2.1, Site Planning. In addition, this chapter also describes the concrete installation procedures on site, specific to Advant Controller 160, see Section 2.2, Installation Procedures.

This chapter does not, however, provide a complete list of measures to take with respect to environment and other conditions on site. The equipment should be adapted to the actual application by way of thoroughly accomplished system definition, ordering and design. You can find descriptions of alternative solutions, design considerations, and so on, elsewhere in this manual.

Since each Advant Controller system is designed to meet your specific requirements, there is no standard configuration that describes every system. Therefore, certain areas of the following instructions are meant only as a guide for planning your specific installation. However, some of the information covers specific requirements for proper system and equipment operation, you cannot modify these requirements. The difference between a recommendation and a requirement is clearly defined as necessary.

Installation of options is often described in dedicated user’s guides. For information about available documents corresponding to desired options, see Section 1.5, Related Documentation.

All information given in this chapter relates to standardized models. Where alternatives exist, a typical alternative is described.

2.1 Site Planning

2.1.1 Site Selection and Building Requirements

When you are planning a control system installation, please consider the following points, among others:

- The surrounding environment and atmosphere.
- The temperature in the room where the equipment is to be located. This includes an estimate of the resulting temperature rise with respect to the power dissipation from the planned equipment.
- The proximity of the control room to the process.
- The size and shape of the control room which is to accommodate all the required equipment.
- The lighting for a control room, which should be powered by a power source independent of the system equipment. A battery-powered emergency lighting system is recommended.
- The minimum distances from a cabinet to walls and ceiling required to obtain satisfactory results from different areas.
- The weight of the equipment and the corresponding requirements of the floor construction.
- Ease of access for moving equipment in and out of the control room.

- Space, suitably furnished for maintenance.
- The free space in front of cabinets. Also reflect on how much space is required to fully open either a left-hand or right-hand hinged cabinet door (both exist). There must always be space left for safety reasons even with open doors.
- Spare area for future enlargement of the equipment.
- A well-developed process connection, with or without marshalling facilities.
- Grounding by an effective net of copper bars.
- Cable routing with respect to installation rules.
- Availability of power and other utilities.
- Standards and legal regulations to be followed.

The following sections examine some of these factors in detail and provide recommendations and requirements as necessary.

2.1.2 Environmental Considerations

General

Advant Controller 160 is designed for a demanding industrial environment. Alternative cabinetry is available for different degrees of protective rating (IP21, IP41, IP54). Interference from electrical sources is suppressed by a suitable solid design and particular installation rules. Equipment is to be located in a control room or an electric room or distributed in the process area.

The common requirements for the building where the system is to be stored or installed are:

NOTE

> The building should provide an environment such that established environmental conditions are not normally exceeded.

The environmental conditions which Advant OCS products are designed to withstand, during storage and transport as well as during operation, are specified in a separate environmental data sheet. Limit values are given to: Corrosive gases, Temperature, Vibration, Moisture, Electro-Magnetic Compatibility, and so on.

Most applications need no special arrangement. Standard cabinetry and installation according to the rules suffice. Occasionally, you must consider special protection with respect to particular situations.

Sealed cabinets are a good basic solution to prevent damage to electronic equipment from, for example, corrosive gases, moisture and dust. However, sealing prevents the normal cooling resulting from self-convection or forced cooling by a fan. In turn, this reduces, to a large extent, the heat dissipation permitted in a cabinet.

Some alternatives, in addition to those offered by other standard cabinets, follow:

- Sealed cabinet pressurized by clean, dehydrated instrument air.
- Gas cleaning by chemical filter.
- Use of dehydrated air.
- Dust filter.
- Sealed cabinet cooled by a heat exchanger.
  It is reasonable to assume that a heat exchanger may be inoperative for short periods. Under these conditions, the temperature in a cabinet must not exceed 70 °C.

For further information about the environmental immunity, please refer to the data sheet *“ABB Master Environmental Immunity”*.

Temperature

It is important to note the temperature within cabinets and in the surrounding environment and atmosphere. Lower temperatures mean increased system reliability and availability.

The lifetime of wet, electrolytic capacitors and most semiconductors are greatly reduced if the maximum permitted temperatures are exceeded.

For more information on design considerations, see Section 3.1.8.2, Heat Dissipation Permitted in Cabinets.

Vibration

The cabinets must stand on a stable floor, deck or supporting structure, free from vibrations.

If the system equipment is installed in a control room adjacent to large machinery, where frequent major vibrations occur, shock absorbers or an isolation pad may be required to protect the system equipment. Shock absorbers normally protect the equipment from sustained low-level vibrations (vibrations that are perceptible, but not excessive). If vibrations or shock are a major problem, consider more extreme measures to alleviate the problem.

2.1.3 Electromagnetic Compatibility

Interference-free operation requires well-considered planning and realization of the installation, especially with respect to grounding, cable selection and cable routing. Some notes are given in the following sections from a planning viewpoint, while the setup instructions give you detailed information about the actual realization of the installation.

For more information, both theoretical and practical, on the subject of Electromagnetic Compatibility including interference, interference sources and suppression measures, see separate reference documents.

You can obtain CE-marking according to EMC Directive 89/336/EEC for your Advant Controller 160 provided appropriate cabinetry is selected. Please, refer to the ordering documentation.

2.1.3.1 Summary of CE-marking Aspects

CE-marking of the Advant OCS products implies some minor but important changes of the design with respect to cabinetry, mains supply filtering and handling of cable shields at the enclosure port. All to ensure conformity to the EMC-Directive 89/336/EEC.

The following is a summary of the most important changes.

Cabinetry

According to information given in the ordering documentation, Advant Controller 160 shall be located in a radio-proof cabinetry. Please note that the requirement is valid to cabinet for the basic station, I/O cabinet and terminal unit cabinet, if separated.

Standard cabinet RM5yy is radio proof in its basic design for protection class IP 21, IP 41, and IP 54.

Open compartment is not permitted for any part of the controller and its I/O including the terminal units.

Immunity against electromagnetic fields can generally be guaranteed with the cabinet containing metallic doors only.

Erection of Cabinets

Advant OCS mounted in a RM5yy cabinet, can be set up side by side with other cabinet types and other equipment types, but the cabinet side plates must be ordered, or not be removed if included at the delivery.

Where several electronics cabinets of the same type, related to one controller with S600 I/O, are to be set up in the same row, however, it is permissible to leave out or remove the side plates between the cabinets.

Mains Net Filter

Protection against line conducted radio emissions is obtained by means of a special filter placed in the bottom of the cabinet on the incoming supply. One filter for each supply is utilized.

Cable Shields

Cable shields which are to be directly grounded in the cabinet must be **additionally** grounded close to their entrance in the cabinet. The cable sealing at the bottom plate is used.

Shielded cables which are not directly grounded in the cabinet are to be connected via a capacitive decoupling device, located in the bottom of the cabinet.

2.1.4 Standard Layout and Disposition of Cabinets

A series of rules for mounting the controller and I/O in RM5yy cabinets follows. These configuration rules are applied when the customer has no preconceived ideas regarding the design. This is the standard solution, which is important to know when you are planning a control system. The complete list of rules are presented in ordering documentation (see also Appendix C, Cabinet Configuration).

General

If not specifically ordered otherwise, the following configuration rules apply for equipment delivery:

- All cabinets (single or double) sharing the same I/O bus extension for S600 I/O (maximum 20 meter) are connected to the same power switch.
- An Advant Controller 160 with I/O is delivered in a number of single or double cabinets.
- Up to five cabinets, each with two subracks can be connected to the same electrical bus extension.
- You can add an extra, seventh cabinet if necessary to house terminal units. This cabinet is placed to the right and cannot contain an I/O subrack. Cables with extended length have to be used from the I/O subracks.
- An I/O subrack is not filled with more than 18 modules, two empty positions are kept as spares for the future.
- In each double (single) cabinet, space for one mounting bar (for terminal units) is left unused.
- The modules are placed in the I/O subracks in the order AI, AO, DO, DI starting in subrack Number 1.

Location of S600 I/O Cabinets

The configuration of cabinets is illustrated in Figure 2-1.

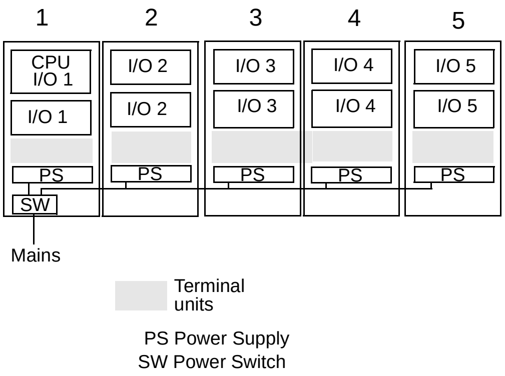


Figure 2-1. Standard Cabinet Configuration (Maximum)

- Normal start configuration is a single cabinet.
- With the cabinet for the basic station to the left, the building direction is to the right.
- One set of power supplies for field equipment, if included, is placed in cabinet No 2.

- Connection units are placed only within the same double (single) cabinet that houses the corresponding I/O subrack.

2.1.5 Grounding

Grounding in General

The signal processing electronics in Advant OCS, as well as all interference suppression for external signals, are normally directly grounded to chassis and plant earth. The plant earth potential must be stable and well defined, even in the event of ground fault in low- and high-voltage equipment or lightning strike. This claim for a grounding system is common to the high-voltage equipment. The earth line joining the grounding systems should be ≥ 35 mm^2 Cu.

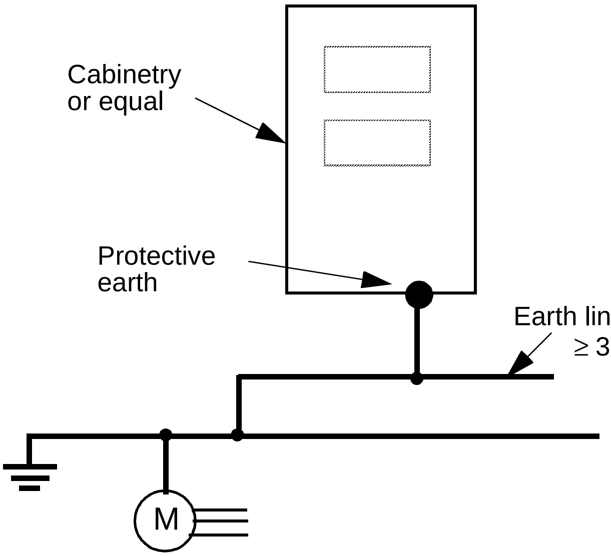


Figure 2-2. Grounding of Electronic Equipment

Protective Earth

Always provide Advant OCS cabinets supplied with 230 V a.c. with a protective earth.

Grounding of Signals and Voltage Supply

For minimum interference and maximum accuracy, it is normally most effective to ground the signals from transducers directly in the grounding bar in Advant Controller 160. For freedom from interference, it is also advantageous to ground supply voltages for transducers, sensing voltage for contacts, load supply voltage, and so on.

You may have to deviate from these two basic rules in order to adapt to other requirements such as measurement techniques or safety regulations. In such cases, you must ensure that, for example, differential inputs for analog input signals are used or that digital inputs and outputs are divided into groups in the terminal unit, with the possibility of supply voltage distribution and earthing in other equipment.

A consequence of requiring local grounding of a signal at the transducer location may be a requirement for a completely individual voltage supply to each transducer. In such cases, you can use a bar with the terminal block and fuse equipment required by the application.

If the transducer has galvanic isolation of the supply from the electronics otherwise, you can ground its signal zero freely and where it is most suitable for measurement accuracy without special voltage supply requirements such as group division, fusing and grounding.

2.1.6 Cables

When you are planning for the cable routing in the plant and selecting suitable cables to use, there are some restrictions and rules to follow. These touch upon, among other things:

- The distance between Advant OCS cables and non-Advant OCS cables.
- The routing of communication cables.
- Mixing of signals and signal types within cables.
- The need for shielded cables.

For further information, please refer to the general document, *Interference-free Electronics Design and Applications*, which also gives examples for choosing cables.

All cables are normally guided into a cabinet from below.

2.1.7 Power Supply and Fusing

General

Normally, supply voltage to Advant OCS supply units and for field equipment can be obtained from the plant a.c. or d.c. supply.

A summary of the main requirements of the supply from a planning viewpoint follows. Primarily an A, B and C network should be available as applicable. Supply A and B refer to redundant networks.

Supply C is feeding modems which use a.c. power supply. In the tropical cabinet version the heating element is also included. Supply C is always an a.c. supply, regardless of whether a.c. or d.c. is utilized otherwise. Preferably supply C should be an uninterruptable power supply. In situations where redundant network A/B is used you can order a power distribution unit, SV542/543, which includes a selector relay and an isolation transformer. The relay selects between, for example network A and B and the transformer makes a secondary grounding of the network possible (adaption class III/class II).

Class II, class III states the network quality with respect to, for example, level of disturbances, voltage variations, and so on (according to IEC standards). Class II denotes higher quality than class III.

You can use power supply units made by other vendors for, for example, sensor supply, and locate those units in an I/O cabinet. Such units must satisfy interference requirements in accordance with the relevant standards in the same test classes as the Advant OCS equipment and they must be CE-marked if equipment is going to be used within the EU and EFTA countries.

Safety Switch

Close to the controller installation, there should be a safety switch enabling **total** power supply disconnection of the equipment. This means a common switch for all supply voltages, for example, networks A, B and C discussed above.

The main use of the safety switch is to disconnect the power supply in a clear and safe way during work in the cabinet.

Install the safety switch in a visible place (outside any cabinetry) within 3 m of the controller installation.

a.c. Supply

Essential information includes:

- For the supply A (and redundant B) class II or class III a.c. networks can be used alternatively as a standard solution.
- For the supply C there are different options. Select a suitable power distribution unit with respect to available class II and class III networks and your requirement on redundancy.
- Single and return (class II), as well as two-phase (class III) connection, of a standard controller are possible.

d.c. Supply

Essential information includes:

- When using a d.c. supply, only battery-supplied systems with a non-grounded battery can be used for direct supply of Advant OCS. With this type of supply, the battery is grounded in the Advant OCS equipment.
- **Supply from a grounded battery requires an isolating d.c./d.c. convertor.**
- Supply C is always an a.c. supply, see heading above.

Protective Earth

Always provide Advant OCS cabinets supplied with 230 V a.c. with a protective earth.

Current Consumption and Fusing

See Section 3.1.3, Power Supply for instructions for making current consumption calculations and for dimensional rules for distribution board fusing. In addition, a quick guide to the power consumption to use whenever you need estimated figures is also located in this section.

Uninterrupted Power Supply

In certain applications, you must guard against brief voltage failures by using an uninterruptable supply. See Section 3.1.3, Power Supply for important considerations in doing so.

2.1.8 Process Connection

There are two ways to connect process signal cables:

- Connection directly to the S*600 I/O process connector with screw terminals.*
- Connection *to terminal units (TX650).*

Connections between I/O modules and the associated terminals units (TX650) are made with prefabricated ribbon or multi-core cables using an S600 I/O process connector with crimp terminals. The cables are available in the price list in several standard lengths (3 m, 5 m, 10 m). Other lengths up to 15 m (50 ft.) can be ordered separately.

The terminal units allow marshalling of the process signals.

There are certain restrictions regarding:

- Internal cable routing
- Signal earthing
- Shield earthing
- Earthing of mounting bars, cable channels
- An open compartment is not CE-marked.

For further information:

- Using ABB standard cabinets, see adequate sections in this installation chapter and the referred document below for further details if necessary.
- Using non-ABB cabinets, see *Advant OCS Installation Rules User's Guide* for compliance with the EMC requirements or the general document *Interference-free Electronics Design and Applications*.

2.1.8.1 Connection Principles, Fusing and Voltage Distribution

There are several ways for marshalling:

- Marshalling at the terminal units.
  This is possible when the process cables are connected to terminal units. Connections between I/O modules and the associated terminals units are made with prefabricated cables using a S600 I/O process connector with crimp terminals.
- Marshalling at the S600 I/O process connector.
  This is possible when the process cables are connected directly or via terminal units connected to the S600 I/O process connector with screw terminals.
- Marshalling at the S600 I/O process and at the terminal units.
  This is possible when the process cables are connected to terminal units. Connections between I/O modules and the associated terminals units are made with non-prefabricated cables fitted to a S600 I/O process connector with screw terminals.

Examples of different solutions include standard installation of the terminal units in the cabinet for the basic station or in the terminal cabinet or installation in open compartments adjacent to the controller system. However, an open compartment is not a CE-marked design.

In addition to terminals for connecting signals, the S600 I/O modules process connector contain terminals for supply distribution and fuses.

To optimize function, price and space requirements groups of signals are formed, for example a common fuse for a group of several digital inputs (example DI635, DI636). Please refer to *S600 I/O Reference Manual* for further examples.The *S600 I/O Reference Manual* shows the amount of signals of the S600 I/O modules sharing the same power supply.

If fusing of individual supply is required it can be arranged with DIN terminal bars.

You can use a DIN terminal bar with connection terminal blocks and fuses for a particular application.

Consider such an alternative at an early stage in the design to ensure that it is located in the cabinet to give optimum cable lengths.

2.1.9 Hazardous Applications

Always combine standard process I/O modules with barriers for ex-environment in an application-adapted way. You may use any of the available barriers on the market which meet your requirements.

2.1.10 High Voltage Switch-gear Applications

Normally, Advant OCS equipment is not designed for direct connection to high-voltage switch-gear.

You use intermediate relays for digital input and output signals as a connecting link. For analog signals, use special measured value converters tested in accordance with relevant standards.

2.1.11 Lightning Strike Protection

Industrial installations and power plants are normally provided with well-integrated grounding nets installed together with the power distribution system. In installations with such grounding systems, it is not necessary to install lightning strike protection unless you are using overhead wiring or suspended cables outdoors.

Large dispersed plants (water supply installations, refineries, and so on) can, however, have an inadequate grounding system and signal cables can be routed above ground. In such cases, lightning strike protection must be used.

Cables outside the grounding system (even for short distances such as 10 m) always require lightning strike protection.

For installation rules, see the general document *Interference-free Electronics Design and Applications.*

2.1.12 Weight and Mounting Dimensions

When placing a control cabinet, you must provide a number of minimum distances from the cabinet to walls and the ceiling in order to ensure satisfactory results. These minimum distances are indicated below.

When cabinets are located next to each other, you can omit from the cabinets the wall cladding on the sides in contact, except from a cabinet which contains equipment which generates any degree of interference (for example, electromagnetic relays with no interference suppression). Consider this when you are ordering the equipment.

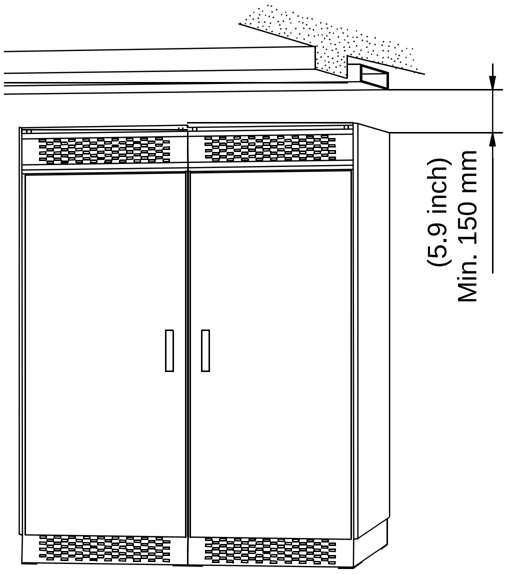


Figure 2-3. Minimum Distance to Ceiling

To ensure adequate ventilation, there should be a free space, 150 mm high, between the top of the cabinet and the ceiling or the underside of any beam, duct or similar structure over the cabinet. When cables enter the cabinet from above, the space available should be at least 1000 mm high to provide working space.

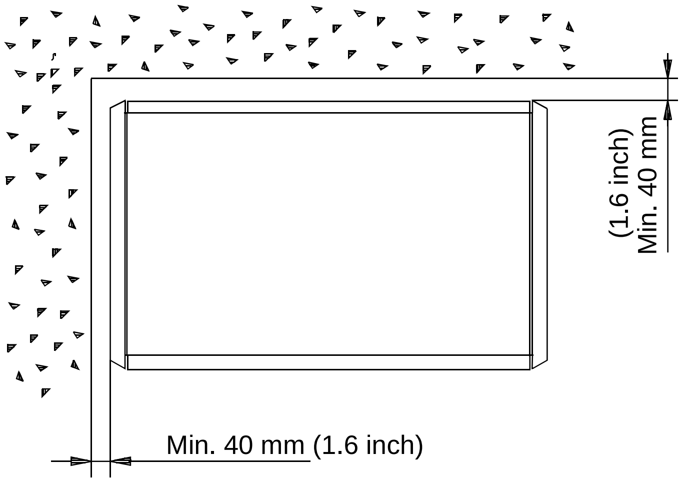


Figure 2-4. Minimum Distance from Rear of Cabinet to a Wall

The distance between the rear and the sides of the cabinet and an adjacent wall should be no less than 40 mm. This also ensures good ventilation.

The free space in front of the cabinet should be the width of the door plus the width of the aisle.

If a double door alternative is used, reflect the space required for any hinged frame. There must always be space left for safety reasons even with open doors or frames bent outwards.

For dimensions of the RM5yy and VSH 200 cabinet types, see Section 3.2.9, Mechanics. You can also find the estimated weight of a cabinet in that section.

2.1.13 Transportation and Storing

Cabinets are packed in a manner appropriate to the means of transport. A pallet is commonly used, so a fork-lift truck or a hand truck is usually the most suitable means of transport on site.

Cabinets are fitted with lifting eyes to facilitate transport with a crane.

NOTE

Please, observe lifting instructions enclosed with the cabinet!

Store cabinets in a dry place, protected against dust.

2.2 Installation Procedures

The goal of this section is to tell you "how to" install and set up the product. Follow the sequence of activities prior to power-up described below. It is assumed that the equipment is assembled and delivered in type RM5yy cabinets. If you are using other types of cabinets, see separate documentation regarding questions such as proper levelling and how to screw cabinets together, for example, *Catalogue SA 36-1E* for the cabinet type VSH 200.

The equipment to be set up is ordered for and adapted to a specific application.

Apply the installation procedures with respect to the specific design!

See Section 2.2.1, Safety Regulations through Section 2.2.9, Radio-Proof Cabinet for general information, followed by individual setup descriptions for different parts of the automation system. You can find this information under the following headings, if relevant:

- Assembly
- Electric Installation (including Power Supply)
- Functional Measures
- Preparation for Start-up.

Ordinary installation drawings, terminal diagram forms and connection documents for site preparation and installation of electrical equipment also apply.

Necessary Outfit

The following kit is a minimum requirement:

- Ordinary hand tools.
- Universal instrument, for example, digital multimeter.
- Test leads with 4 mm banana contacts and reducer contacts for a 2 mm test jack.
- Necessary parts of the documentation listed in Section 1.5, Related Documentation.
- Specific documentation enclosed at delivery, drawings, and so on.

2.2.1 Safety Regulations

Always follow the instructions below when installing and operating an Advant Controller system to minimize the risks of injury to personnel and damage to the equipment. Local statutory regulations, to the degree that they are stricter than the following instructions, take precedence.

2.2.1.1 Personnel and Process Safety

DANGER – CAUTION

Observe the following:

- Use only approved hoisting equipment when lifting cabinets. See lifting instructions enclosed with the cabinet.

- Never switch on the voltage supply of the cabinet during installation work.
- **Work with care when supply voltage is applied in the system. The voltage in the cabinet can cause injury and can even kill a human being.**
- Make sure that everyone working on the installation knows the location of the safety switch and the main power supply switch to the Advant Controller 160 equipment and how to use it.
- When the subsections of the process are checked and a test run has been performed, a responsible person is to check out interlocking chains, and so on.
Inform all assembly personnel about test runs to be performed.
- Process technicians are to be present when testing and operating the process objects.
- Never press the **Res** (system reset = initialization) button if you do not know what happens in the system with an initialization (see Section 2.4, Start-up Procedures).
- Remember that the control system can be controlled from an Engineering Station connected at another node via Advant Fieldbus 100. For example it can be stopped, configured and started remotely.
- Remember that an Advant Controller 160 starts automatically when voltage is applied if this is not prevented by setting the **Mode** selector in the STOP position.

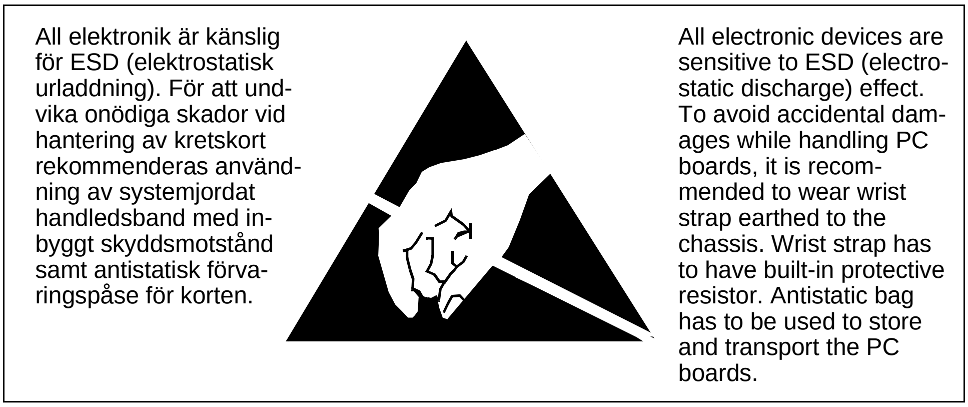
2.2.1.2 Machine Safety

CAUTION

Observe the following safety rules:

- Avoid discharges of static electricity by grounding both yourself and tools before handling circuit boards and other parts of the equipment.
- Use the grounded wristband installed in the cabinet and the available folding working surface (service shelf) when handling parts of the system.
- Handle the circuit boards carefully, particularly those which contain MOS components which can be damaged by static electricity discharges. Note the warning label on the circuit boards.
- Use, as far as possible, the grounded wristband when handling boards not stored in envelopes of conductive plastic. This gives optimum protection against static electricity discharges.
- Always store circuit boards in envelopes of conductive plastic when not installed in the system rack.
- Always switch off the voltage before extracting a board which cannot be exchanged while under voltage. See Chapter 5, Maintenance. Wait a sufficient time for the capacitors to discharge.
- Switch off voltage to the system and withdraw all boards at least 20 mm before electrical welding is performed near the controller system.
- A warning label is fixed in the system to draw attention to possible damage by ESD (Elec-

tro Static Discharge).



All elektronik är känslig för ESD (elektrostatisk urladdning). För att undvika onödiga skador vid hantering av kretskort rekommenderas användning av systemjordat handledsband med inbyggt skyddsmotstånd samt antistatisk förvaringspåse för korten.

All electronic devices are sensitive to ESD (electrostatic discharge) effect. To avoid accidental damages while handling PC boards, it is recommended to wear wrist strap earthed to the chassis. Wrist strap has to have built-in protective resistor. Antistatic bag has to be used to store and transport the PC boards.

Figure 2-5. Warning Label regarding ESD

2.2.2 Unpacking and Storing

If the packaging is opened for a delivery check, reseal it if the cabinets are not to be installed immediately.

Store cabinets in a dry place, protected again dust. See the data sheet *ABB Master Environmental Immunity.*

Avoid fixing labels on painted surfaces. If these remain in place too long, the surface can be affected.

Use care when unloading and transporting cabinets. A fork-lift truck is usually the most suitable means of transport.

Cabinets are fitted with lifting eye bolts to facilitate transport with a crane.

NOTE

Please, observe lifting instructions enclosed with the cabinet!

Temporary Installation of Heating Element

If a cabinet is provided with a heating element, activate it as soon as possible after the cabinet is unpacked to prevent corrosion.

Connect the mains supply a.c. (phase, return and protective earth) directly to the terminal blocks of the element unit.
Make the connection **temporarily**. See the delivery documentation for information on element location and terminals to be used.
When the cabinet is finally installed, supply the element according to the information given in Section 2.2.10, Power Supply Connection.

2.2.3 Location

The cabinet is to stand on a stable floor, deck or supporting structure, free from vibrations, and is to be either screwed or welded to this surface. Minimum distances to walls and ceiling are listed in the Section 2.1.12, Weight and Mounting Dimensions.

Access to the rear of the cabinet is not necessary.

If required, you can remove the wall cladding on the sides in contact when two or more cabinets related to one controller with I/O are installed next to each other. The width of the cabinets is reduced by 35 mm (for each) panel removed. The cladding should remain in place, as protection, on any cabinet which generates any degree of interference.

2.2.4 Erecting the Cabinets

The floor should be level and well suited for erection (Swedish building standard-AMA tolerance 3B or class 2), so that a number of cabinets can be bolted together without any additional work being required.

If the floor is not sufficiently level, the cabinet base may be askew, making it difficult to open or close doors.

When you are erecting the cabinets, you can move them to the right position by inserting spacers, and so on, between the base frame and the ground. You can raise the cabinets using adjusting bolts in the base (one in each corner) before they are erected.

NOTE

Cabinets must not rest on the adjusting screws after erection.

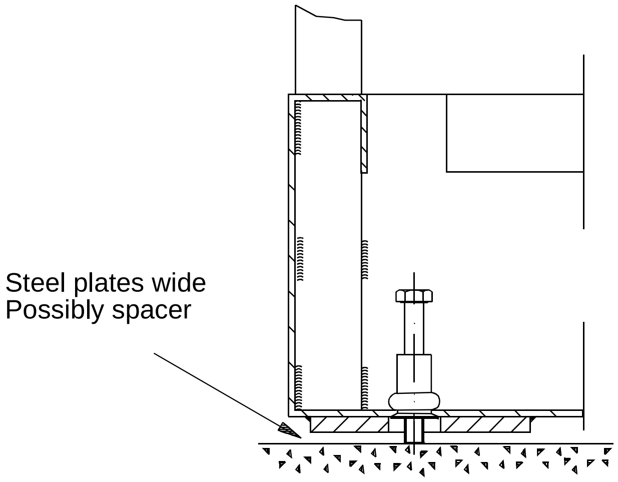


Figure 2-6. Cabinet Leveling Screws

2.2.5 Cabinets Screwed Together

The cabinet sides feature eight holes for screwing cabinets together with M8x12 screws, washers and nuts.

Tighten the screws to 20 Nm maximum.

With sealed cabinets, fix a self-adhesive foam rubber strip around the edges of one side wall before screwing the cabinets together.

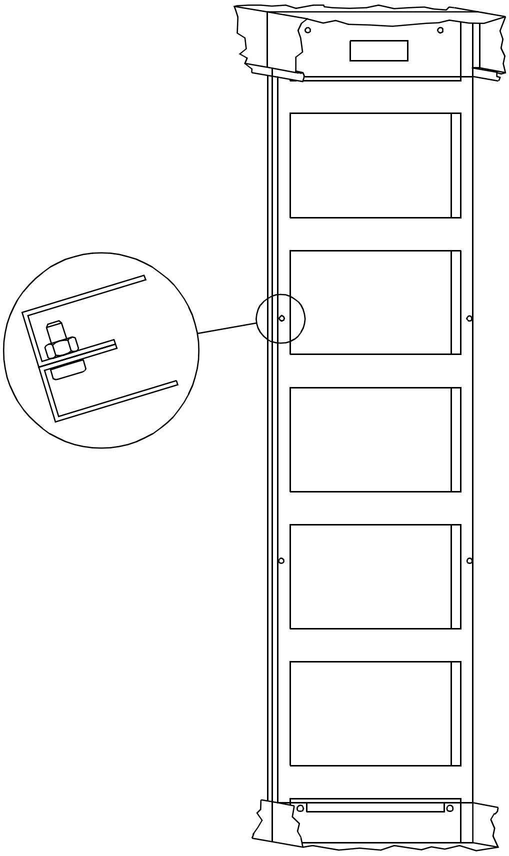
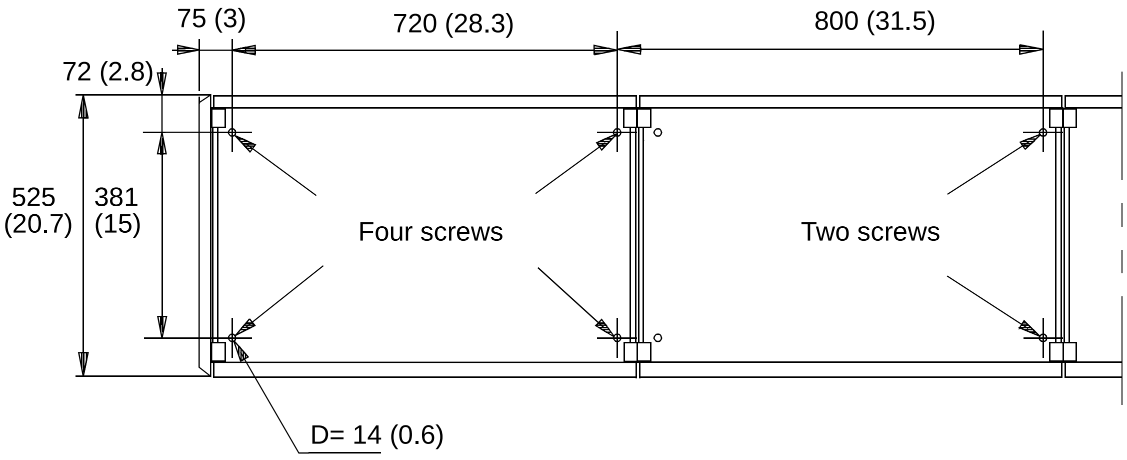


Figure 2-7. Screwed Connections

2.2.6 Fixing Cabinet to Floor

Different methods for fixing a cabinet to the floor follow.

Screwing to Floor



All measurements in mm (inch.)

Figure 2-8. Screwing of Cabinet to Floor

Screw individual cabinets, and the first (left-hand) cabinet in a row of cabinets, to the floor with four screws, one at each corner. Screw the other cabinets to the floor with two screws each at the right.

The bottom features holes, 14 mm (0.6") in diameter. These holes permit you to adjust the cabinet location after holes are drilled in the floor.

If drilling is necessary, make sure that no dust or other foreign matter enters the equipment in the cabinet.

See Figure 2-6, Figure 2-8 and Figure 2-9.

Welding to Steel Section

CAUTION

All circuit boards must be extracted before any welding work is performed.

See Figure 2-10.

Fixing to Computer Room Floor

When the fixing points in the cabinets do not coincide with the structural beams, you must fix the cabinet to the floor itself using expander bolts.

See Figure 2-11 and Figure 2-12.

Examples of Installation Details

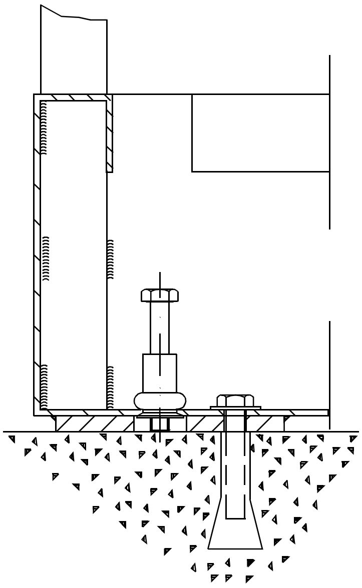


Figure 2-9. Screwing through Holes in Bottom

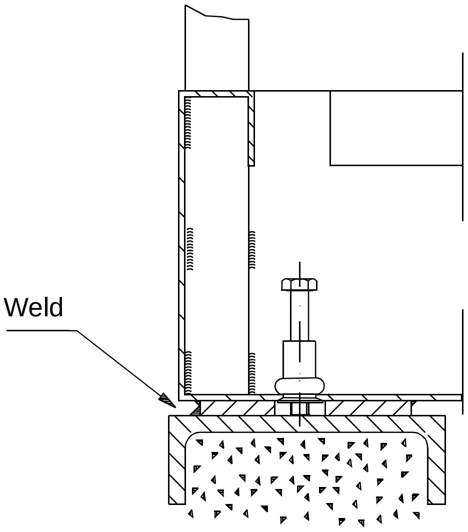


Figure 2-10. Fixing of Cabinet by Welding to Steel Section

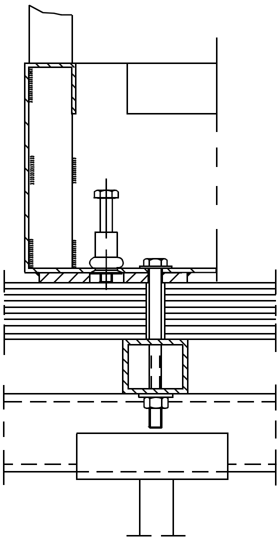


Figure 2-11. Fixing of Cabinet to Computer Room Floor, Variant 1

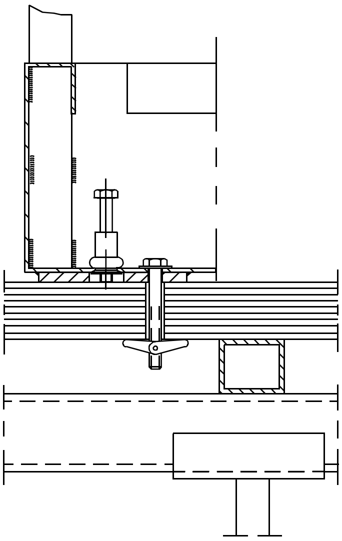


Figure 2-12. Fixing of Cabinet to Computer Room Floor, Variant 2

2.2.7 Grounding

This section shows you **where** to ground in an Advant Controller cabinet. If necessary, it also shows you **how** to ground.

You should be aware of the common *Advant OCS Installation Rules*, which establish the principles of grounding and answer the questions of **when** a piece of equipment, a circuit or a cable shield should be grounded and **why** it should be grounded. It also gives alternative solutions adapted to specific plant requirements.

2.2.7.1 General

An RM5yy cabinet forms a stable ground plane for all equipment accommodated.

The signal processing electronics in the controller, as well as all interference suppression for external signals, are normally directly grounded to chassis and plant earth.

2.2.7.2 Protective Earth

The mains distribution normally includes a protected earth (PE) wire. Connect this to the PE terminal block on the primary Power Switch Unit or the Mains Net Filter, if included. (See the circuit diagram enclosed at delivery.)

You are directed to use cable lug connectors when connecting to any earth screw.

2.2.7.3 Earth Line

Ground the cabinet with a copper lead (≥ 35 mm) to the plant earth line.

Use any of four earth screws placed in the corners of the cabinet floor. You are directed to use a cable lug connector.

Individually connect several cabinets in a row to the plant earth line.

2.2.7.4 Grounding of Process Cable Shields

General

Advant OCS or rather the application itself puts some limited requirement on cable shielding. Only a few types of process signals must be shielded and treated in a special way when entering the cabinet for the basic station. In the continued description of CE-marked and not CE-marked controller design these cables are denoted **category A** and they include:

- Low level analog input signals
  - Accuracy requirement ≥ 12 bits
  - Pt 100 and Thermocouple.
- High-frequency pulse transmitter signals
- on-board rotational speed inputs to Processor Module PM644, PM645B, PM645C.

Normally a single shield is used and it is grounded in the controller end of the cable. Sometimes the application requires a local grounding of the cable shield close to the transducer. Specific rules apply then.

By different reasons other field cables may be shielded too. For example following a company/plant standard. There is no requirement from the controller viewpoint. These field cables are denoted **category B**.

To get a comprehensive view also the treatment of **unshielded** cables are described below.

Common to all cabinet designs are the horizontal mounting bars (DIN) close to the bottom of the cabinet. One bar at the left-hand side and one at the right-hand side. They are used to mechanically anchor all types of field cables, shielded and unshielded, when entering the cabinet. You use a cable clamp to press the cable against the bar or adjacent cable if several cables are pressed together. Which bar you use depends on the further routing of the cable in the cabinet. See Section 2.2.8, Cable Routing in Cabinets.

CE-marked Design

Shields of **category A** cables which are to be directly grounded in the cabinet must be **additionally** grounded close to their entrance in the cabinet. The cable sealing at the bottom plate is used according to Figure 2-13 below. The shield must then be run all the way up to the relevant S600 I/O module as shown in the Figure 2-13.

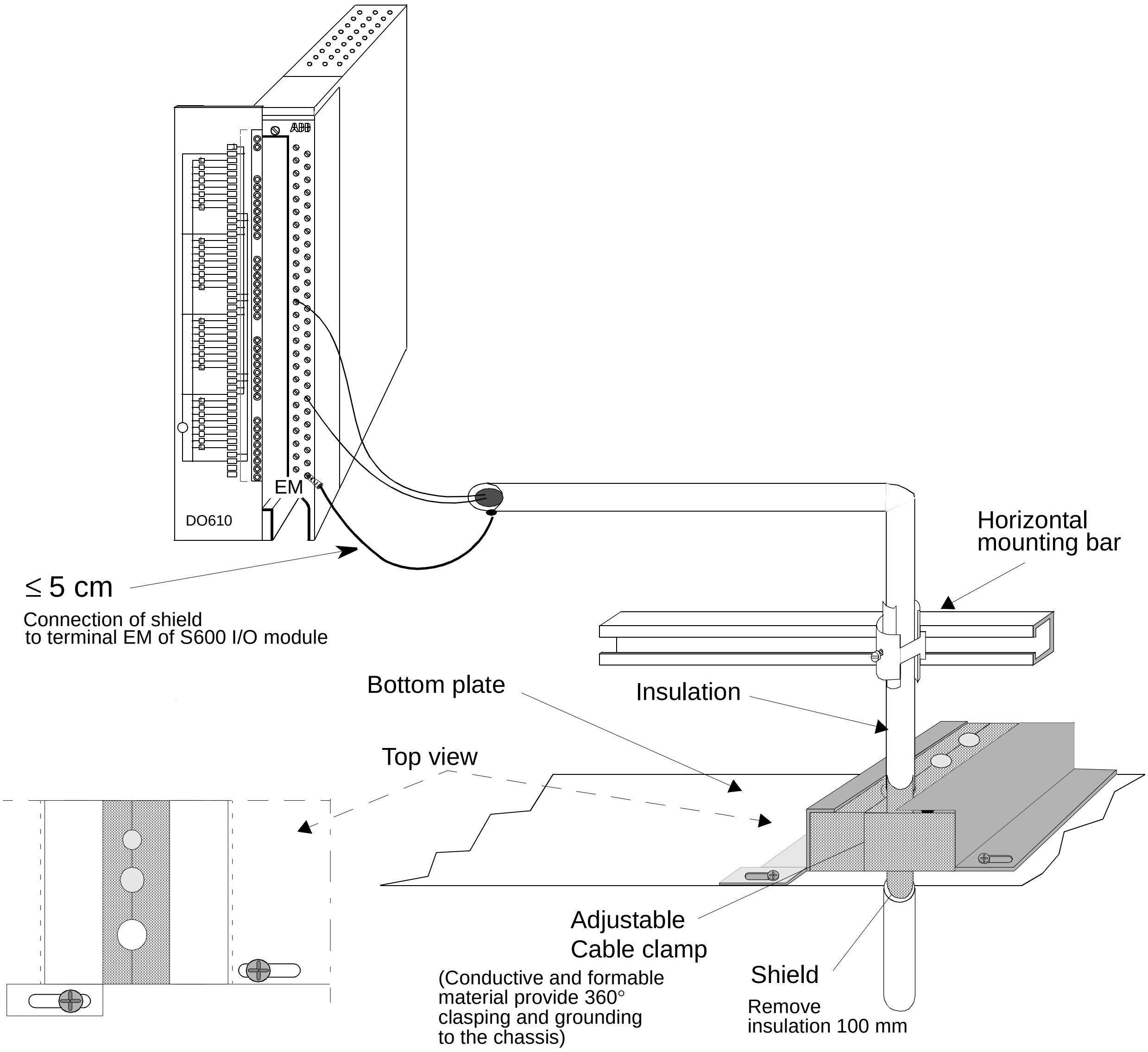


Figure 2-13. Handling of Cable Shields in a CE-marked Cabinet (Example with S600 I/O)

If there is a requirement of local grounding of a cable shield for, for example, a thermocouple application, cable with double shield should be used. The inner shield is grounded locally at the transducer while the outer shield is grounded according to Figure 2-13.

Shielded cables of the category A which are grounded locally at the transducer are alternatively to be connected via a capacitive decoupling device, located in the bottom of the cabinet. That is similar solution to that used for certain communication cables. See Section 2.2.7.5, Grounding of Communication Cable Shields.

Shields of **category B** cables can be handled at the entrance of the cabinet in the same way as category A cables.

If the shielded I/O process cable is connected to a terminal unit an internal shielded process cable between S600 I/O module and terminal unit is used. The shield of this internal cable is connected to the shield of the incoming I/O process cable at the terminal unit (by connecting both shields to the same screw terminal of the terminal unit).

Unshielded process I/O cables can be mixed with shielded process I/O cables. However to get the best grounding of existing shields by the cable sealing at the bottom of the cabinet you should preferably arrange shielded and unshielded cables separated in groups. Try to mix cables with different dimensions in a way that ensure best possible connection of shields to ground (clasp 360°).

Not CE-marked Design

If a conventional cabinet is used the attachment of the cable shield and anchoring of the cable is coordinated by using the horizontal mounting bar, see Figure 2-14. The shield of a **category A** cable must furthermore be run all the way up to the relevant connector or EM-terminal of connector. The point of grounding is shown in Figure 2-13. Use a short lead ≤ 50 mm.

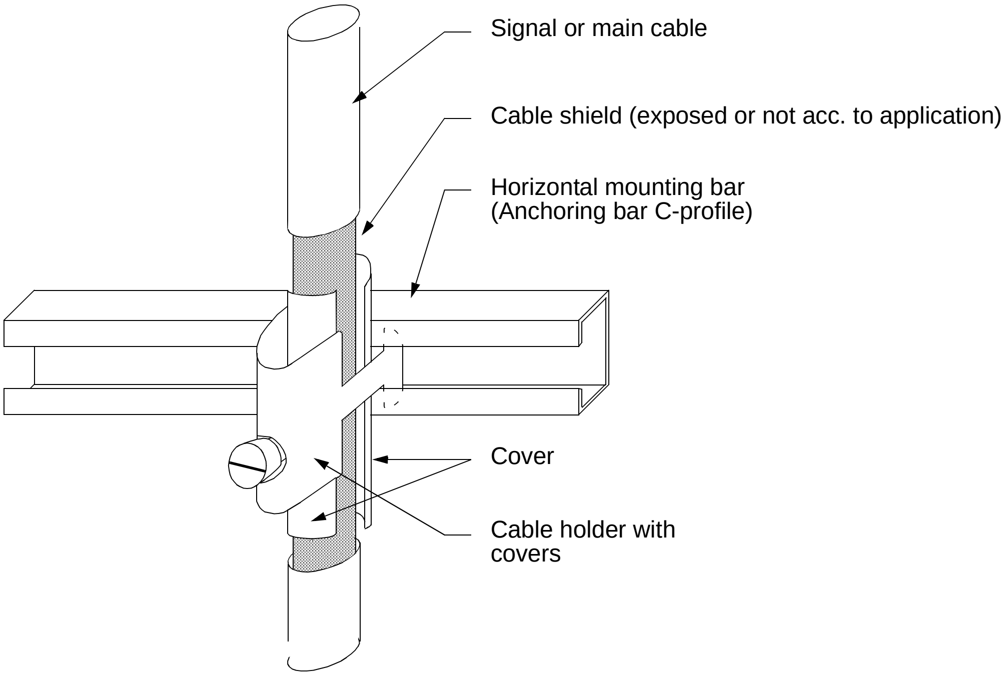

Signal or main cable
Cable shield (exposed or not acc. to application)
Horizontal mounting bar
(Anchoring bar C-profile)
Cover
Cable holder with
covers

Figure 2-14. Handling of Cable Shields in a not CE-marked Cabinet

Shielded cables of the category A which are grounded locally at the transducer shall be left ungrounded in a cabinet which is not CE-marked.

Unshielded process I/O cables can be mixed with shielded process I/O cables.

2.2.7.5 Grounding of Communication Cable Shields

General

Communication cables shall be routed directly to the actual connection unit, modem or communication module in a subrack. Never open up a cable shield when entering the cabinet. The grounding of the shield to the chassis, directly or via a capacitor is normally determined by the type of communication. You must reflect the whole installation of the communication bus to comply with a main rule: **A bus communication cable shield must be directly grounded but only in one end of the bus. That is in the cabinet where the first/last connected Advant Controller (or other node) is located.**

This instruction is valid to coax cable and conventional shielded multi-lead cable as well. It is a supplement to the installation information given in separate communication user’s guides.

CE-marked Design

In addition to the general instruction found above, further interference suppression of the cable shield is made at the enclosure port by individual methods adapted to the different types of communication. The schematic principles of direct grounding and radio frequency grounding by a capacitor are shown in Figure 2-15.

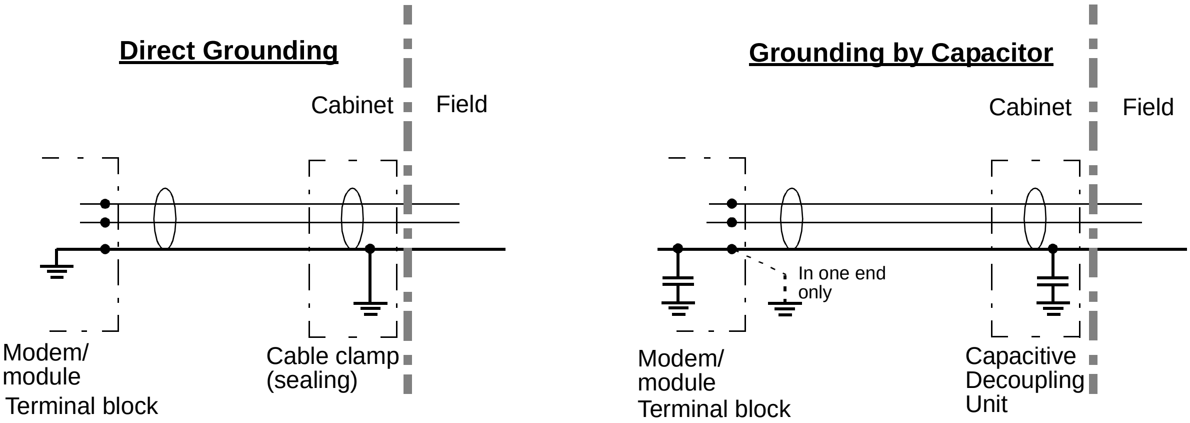


Figure 2-15. Principles of Grounding of Communication Cable Shields in a CE-marked Design

For direct grounding of the communication cable shield, the illustration in Figure 2-13 is applicable.

The grounding via a capacitor is based on a Capacitive Decoupling Unit, which is mounted on the horizontal mounting bar. The cable then passes the sealing at the cabinet bottom unstripped. See Figure 2-16.

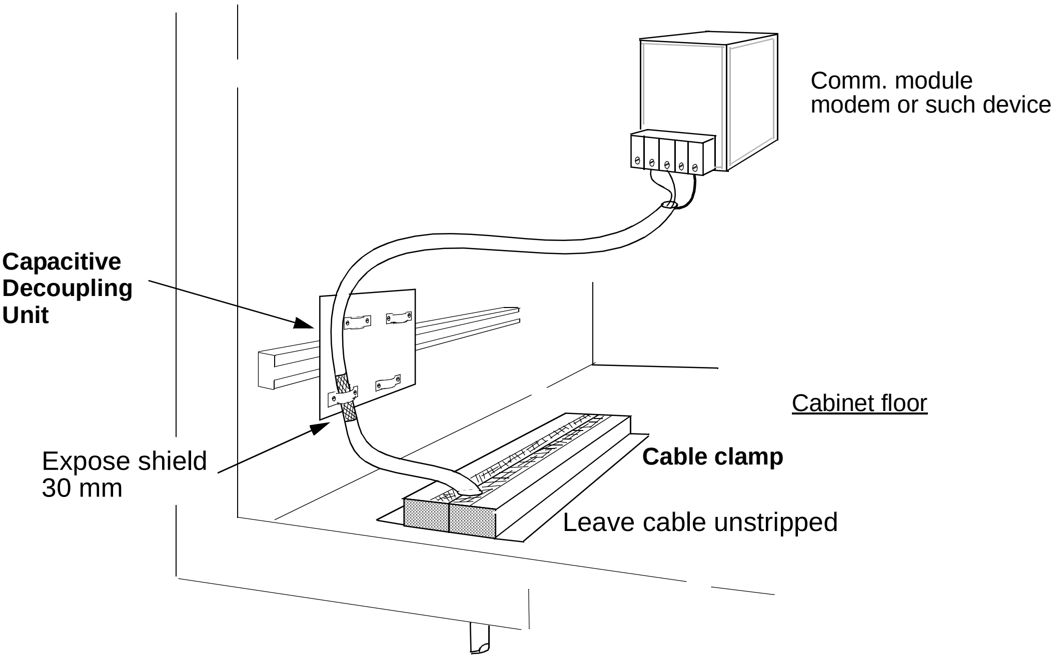


Figure 2-16. Communication Cable Shield Grounded by Capacitor

Each unit takes up to four communication cables and it also provides the mechanical anchoring of the cable. Two units can be mounted side by side or, if necessary, on top of each other. Certain spacers are used then. This imply a maximum of 4 units on a mounting bar (16 buses).

The application of method with respect to communication type is given in Table 2-1.

Table 2-1. Methods of Handling Communication Cable Shields

Type of Communication	Grounding of Shield Directly	Grounding of Shield via Capacitor
Advant Fieldbus 100, Coax	–	Yes
Advant Fieldbus 100, Twisted pair	–	Yes
PROFIBUS via PM644	Yes	–
RCOM, EXCOM, MODBUS, SIEMENS 3964(R) via SC610/CI532	Yes	–
V24/RS-232-C, for example for a panel via PM640/PM644/PM645/PM646	Yes	–

Table 2-1. Methods of Handling Communication Cable Shields (Continued)

Type of Communication	Grounding of Shield Directly	Grounding of Shield via Capacitor
RS422 for High Speed Link between PM645/PM646 modules	No additional measures. Grounding assured by the used connection cable sets TK661and TK662.	
RS422 for rotational speed signal input	No additional measures. Grounding assured by the connector COUNT of the Processor Module PM644, PM645B and PM645C, according to category A (see Section 2.2.7.4, Grounding of Process Cable Shields)	
Bus Extension to S600 I/O	Refer to Section 2.2.13, Bus Extension to S600 I/O	

Not CE-marked Design

The description given under the heading **General** is adequate. The cable is mechanically anchored to the horizontal mounting bar close to the bottom of the cabinet. Leave the cable unstripped. Use a cable clamp to press the cable against the bar or adjacent cable if several cables are pressed together.

2.2.7.6 Grounding of Process Signals

There are three applications of signal grounding directly to the chassis. (High-frequency grounding by capacitors is always provided and not discussed in this context.)

1. Signals can be grounded to the chassis by the S600 I/O module. This quality is determined by the selection of I/O modules. Some I/O module types require grounded signals while others can be applied to non-grounded signals (to grounded signals too).
   Please see the *S600 I/O Hardware Reference Manual* and the *S600 I/O Hardware Advant Controller 160 Reference Manual* on a case-by-case basis.
2. Signals can be commonly grounded by grounding the reference 0 V of centralized power supply for loads and sensing. Such a power supply system must be grounded to the same earth line as the Advant OCS system.
   If the power supply unit is placed in the controller or I/O cabinet, 0 V is grounded to the protective earth screw.
   Remote grounding of loads and sensors is then impossible!
3. Individual grounding of a signal in the controller cabinet is possible (if it is applicable with respect to module type selected).
   The 0 V signal connection at the I/O module is reconnected and grounded to the mounting rail. Lead length is not critical.
   Such an application requires that the signal not be grounded otherwise, for example, not locally grounded at load/sensor or not grounded via a power supply grounding.

You must follow the main rule:

CAUTION

Do not ground a signal at different points in the plant.

2.2.7.7 Grounding of Additional Equipment

Treat additional power supply units of different types, aimed at load/sensor supply and modems, and so on, erected in the controller or I/O cabinet, in the following way with respect to grounding:

- Connect the apparatus chassis (or PE terminal) to the protective ground via one of the power distribution sockets on the power switch unit or directly to the cabinet chassis.
- Consider application-adapted grounding of power supply 0 V. If desirable, connect the 0 V terminal to the chassis. It is preferable that you use the protective earth screw.

2.2.7.8 Spare Conductors

Spares in field cables are to be grounded within a cabinet, in case of a CE-marked design.

2.2.8 Cable Routing in Cabinets

Cables are practically routed on either side (right and left) of the cabinet depending on the final destination. The physical item destination for an actual apparatus, and thereby the connection point, appears in the circuit diagrams and other installation drawings enclosed at delivery.

The assigned space for cables that are entered in the floor opening is shown in Figure 2-17.

For your information, the space for the factory assembled cables is also indicated in Figure 2-17. Regard the latter cables and leads as sensitive to disturbances and keep them away from cables coming from the plant. You will encounter these areas only when the system is enlarged by additional equipment, for example, a module and terminal unit.

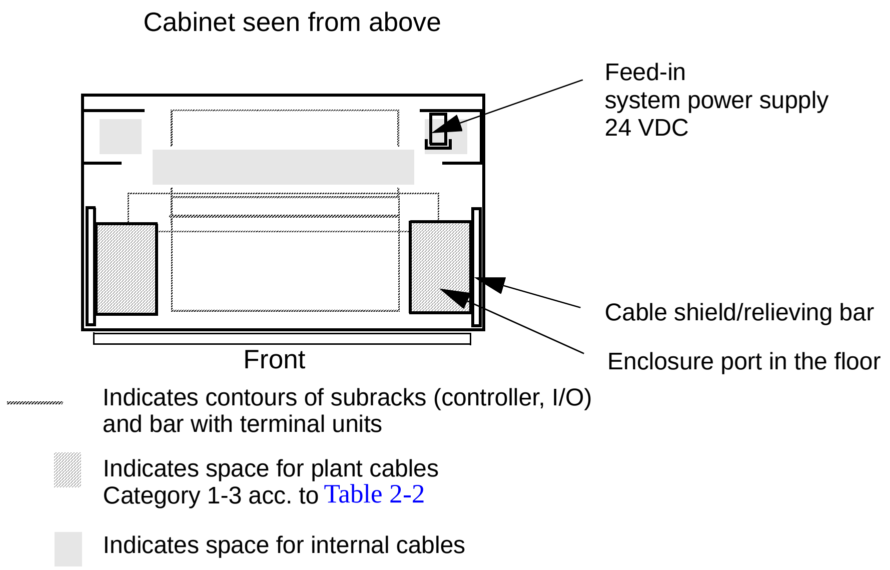

Cabinet seen from above
Feed-in
system power supply
24 VDC
Cable shield/relieving bar
Enclosure port in the floor
Front
Indicates contours of subracks (controller, I/O) and bar with terminal units
▨ Indicates space for plant cables Category 1-3 acc. to Table 2-2
▢ Indicates space for internal cables

Figure 2-17. Assigned Space for Cables in a Cabinet

There are some restrictions in mixing cables within a cabinet due to the risk of interference. To describe the simple rules applicable at site installation, cables are divided in categories. See Table 2-2 and the following rules:

- Within a category, you can mix cables arbitrarily.
- Keep the distance between cables belonging to different categories ≥ 50 mm.
- “Cabinet internal” couplings have their own defined spaces for routing.
  Always keep the distance to other cables ≥ 50 mm.

Table 2-2. Cable Categories in a Cabinet

Cable /Application	Category
Power supply a.c. or d.c.	1
Process I/O, shielded and unshielded cables	2
Communication	2
Bus extension to S600 I/O (1)	3

(1) Bus extension for S600 I/O is normally routed between cabinets in a special way, as illustrated in Section 2.2.13, Bus Extension to S600 I/O.

For minimal RF emission the I/O bus extension cable shall have a distance ≥ 200 mm from the CPU connection cables (see Section 2.2.13, Bus Extension to S600 I/O, paragraph Electric Installation).

Route cables in horizontal cable ducts when applicable.

Fix cables with cable straps.

2.2.9 Radio-Proof Cabinet

All RM5yy cabinet versions are radio-proof in their basic design.

Certain installation rules apply. Refer to the particular sections in this User’s Guide.

2.2.10 Power Supply Connection

2.2.10.1 General

Cabinets erected side by side, including a basic station with Processor Modules and I/O stations, are regarded as a unit which is joined to the power supply network at one single connecting point, a centralized power switch unit. The switch unit is normally located in the cabinet for the basic station.

The power supply is distributed to the I/O cabinets according to application. The power supply modules in I/O cabinets are connected to the switch unit via ready-made cables and plug-in contacts.

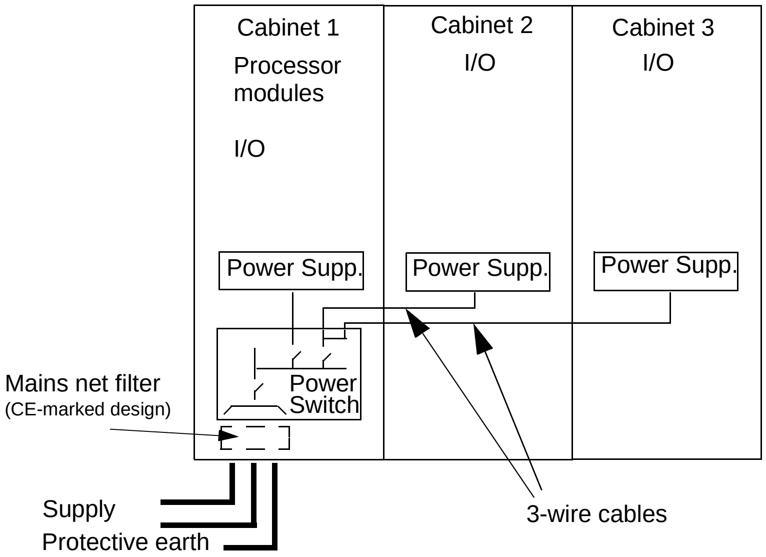


Figure 2-18. Main Principle of Power Supply Connection and Distribution

Mains Power Switch and Distribution

You use the power switch and distribution unit to connect and disconnect Advant Controller 160 to the mains and for distribution of voltage to different units in the cabinet.
The power switch unit contains terminal blocks, miniature circuit breakers and power outlets for, for example, voltage supply units.

Normally, a common circuit breaker disconnects the mains from all cabinets housing the basic station with the Processor Modules and the S600 I/O installation, that is, “hard” related cabinets. Variants can exist. Please refer to the actual delivery documentation for further information.

You can find more information about distribution units and power switch in Appendix C, Cabinet Configuration.

2.2.10.2 Connection of Power Supply Module SA610

In addition to the bus extension connector, both the basic subracks RF615 and RF616 and the extension subrack RF620 have terminals for linking the station supply voltages. These terminals are located on the right-hand side of the subracks. There are two sets of terminals, which enable you to connect the two power supplies (USA and USB). PCB supply rails connect both sets of terminals to all positions.

The station voltage terminals of the basic and the extension subrack must be interconnected. A missing connection can prevent proper operation of the system. If redundant power supply is applied, two station voltage cables TK615 are required.

If you are supplying both the basic subrack and the extension subrack from an in-line power supply module SA610, you must connect the supply terminals of the two subracks by a cable TK615. This cable is a two-pole cable 1.5 mm^2 with Faston terminals designed for the normal distance between the two subracks. It can be connected between USA-USA or USB-USB terminals.

The rated supply voltage for the modules in the station is 24 V d.c. The permissible range of supply voltage is 18 – 30 V measured at the terminals.

The subracks must be earthed via a conductor protective earth (PE). Where both a basic and an extension subrack are installed, connect both to the PE conductor (see Figure 2-20). Connect the

PE conductor with a screw to the earthing/grounding hole located on the right-hand side of the metal base plate of the subrack.

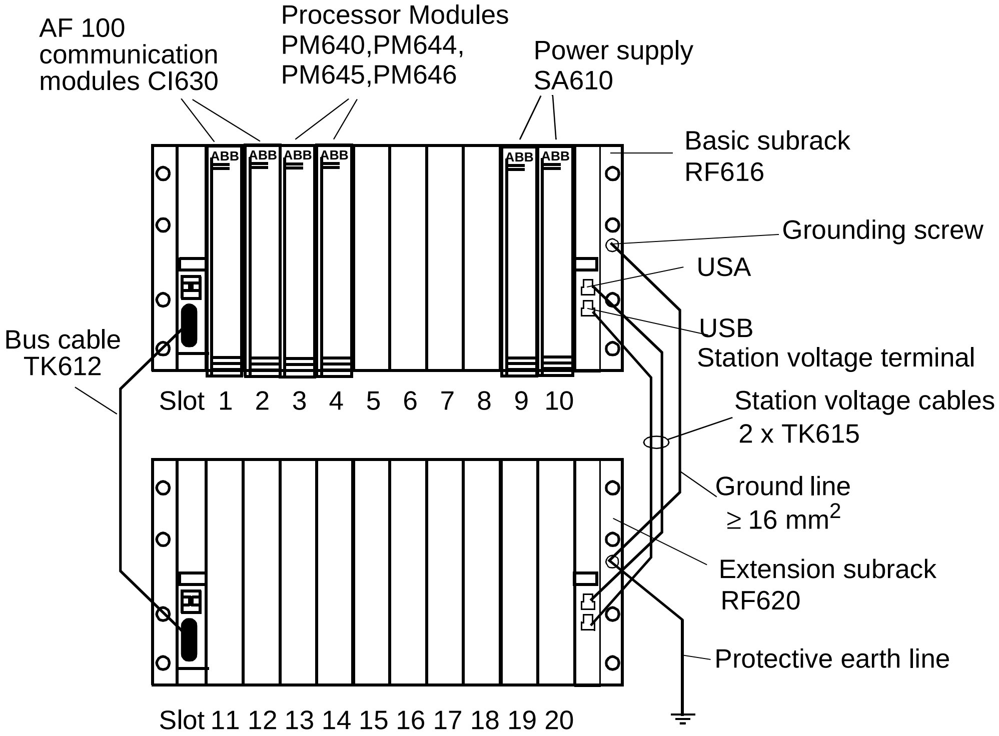


Figure 2-19. Advant Controller 160 basic Station Configured with Two Power Supply Modules SA610

2.2.10.3 Supervision for Power Supply Module SA610

The following figures illustrate two examples of possible configurations:

- Single configuration
- Parallel configuration usable for:
  - increased power supply or

– redundant power supply.

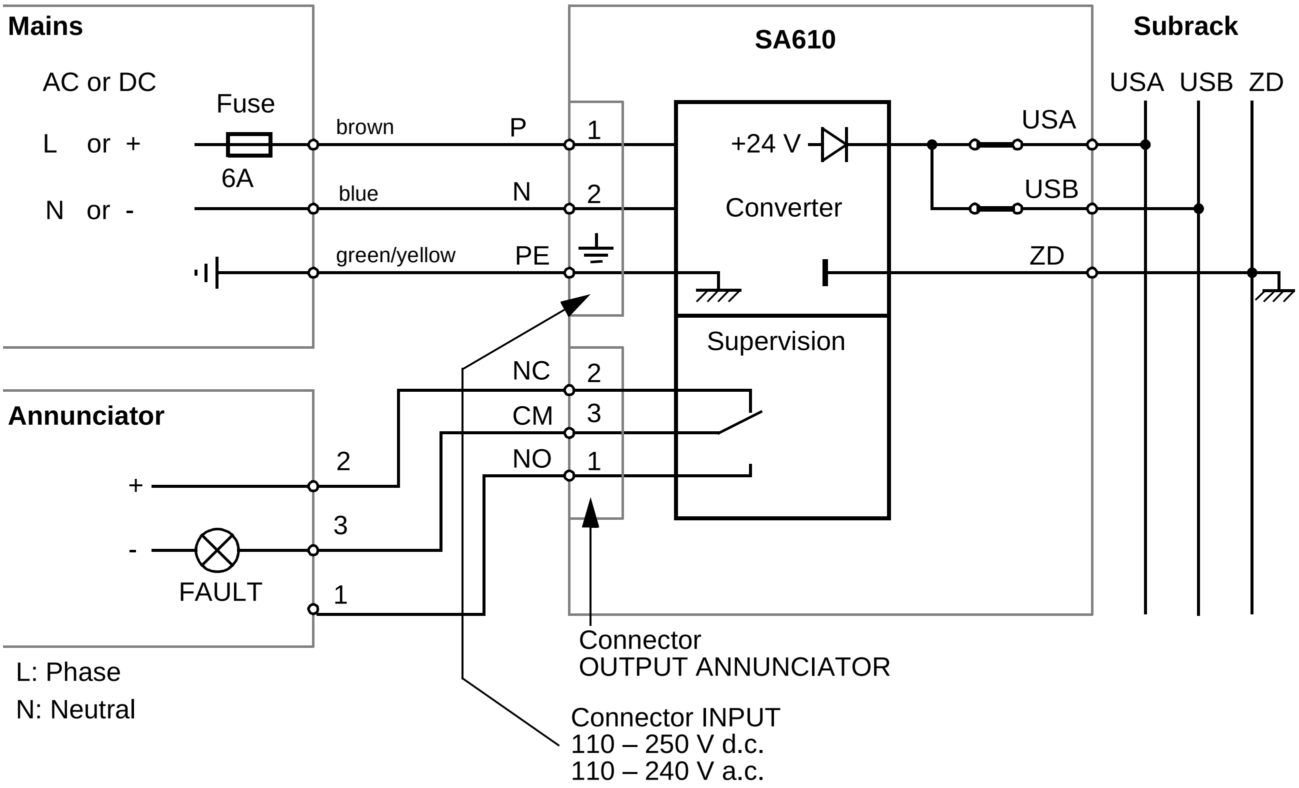


Figure 2-20. SA610 Connections for Single Configuration

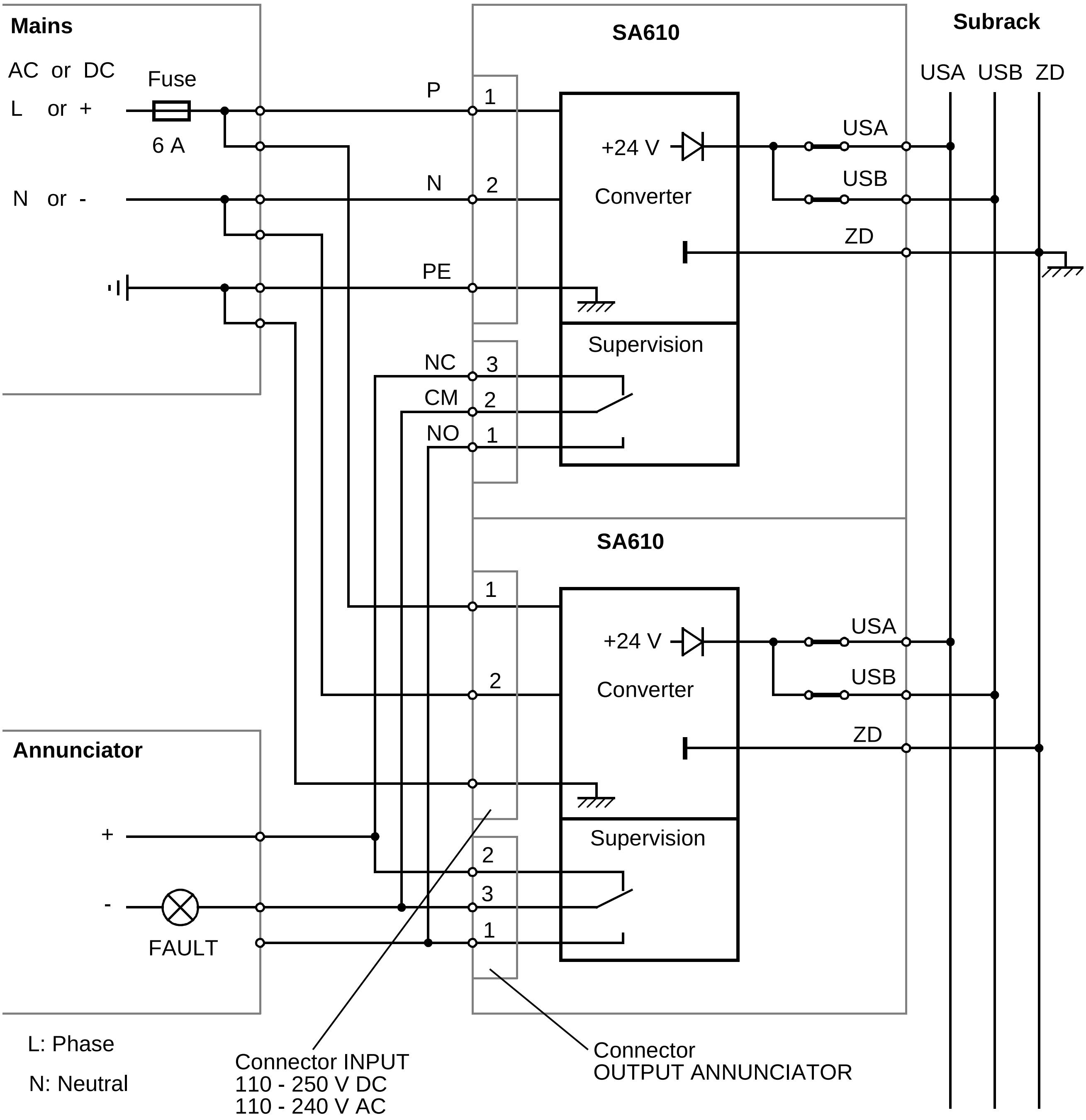


Figure 2-21. SA610 Connections for Parallel Configuration for Increased or Redundant Power Supply

2.2.10.4 Installation

General

Ordering documents show which power supply alternative is applied.
An a.c., d.c., redundant or non-redundant supply is connected to the controller in the same way, in principle. A terminal diagram form enclosed at delivery shows the relevant physical item designations and connection points in the cabinet. You will also find the denominations supply A, B and C applicable.

A summary of the main requirements of the networks A, B and C are given in Section 2.1.7, Power Supply and Fusing.

The installation work to be done, supported by the terminal diagram form (circuit diagram), is:

- Connect network A
- Connect network B (if redundancy)
- Connect network C
- Connect the power supply modules located in I/O cabinets. Use the ready-made cables and plug-in contacts. They are marked with the destination item designations.

CE-marked Design

Protection against line conducted radio emission is obtained by means of a special filter placed in the bottom of the cabinet on the incoming supply. One filter for each supply is utilized.

The cable length between the entrance of the cabinet and the net filter should be as short as possible.

Not CE-marked Design

No additional information than that given under the heading General apply.

2.2.10.5 Heating Element

If a heating element is included in the cabinet, connect it appropriately with respect to external safety switches. Do not disconnect it by the cabinet power switch unit.
The element is automatically disconnected by a relay when the equipment is in operation (24 V d.c. switched on).

2.2.10.6 Preparation for Start-up

Check that the circuit breakers on the power switch units are switched off.

Reflect the relevance of:

- Power switch in the cabinet housing the basic station with the Processor Modules
- Separate power switch in physically distributed cluster of S600 I/O subrack.

2.2.11 Bus Connection to Extension Subrack

Cable TK612 makes the connection between the sub-D connectors on the basic subrack and the extension subrack (see Figure 2-19). Do not use any cables other than the TK612 because the connector pin allocation, the cable impedance and the cable length are precisely optimized for bus extension operation.

2.2.12 Basic Station

The basic station houses the Processor Modules and possibly I/O modules.

Assembly

All equipment included in the basic station is factory assembled. Cabinet erection and similar questions are dealt with in the general setup instructions above.

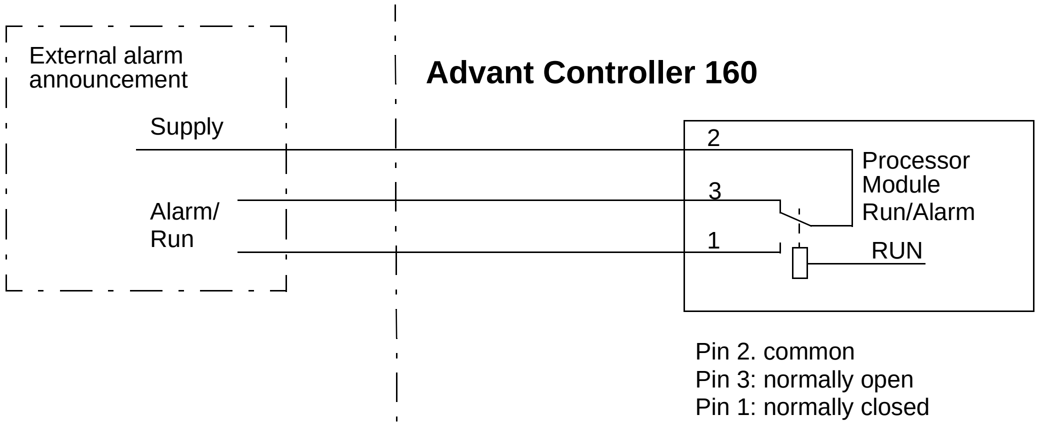
Electric Installation

Apart from the process I/O connections and communication connections, which are treated separately, there is little electric installation. Grounding of the cabinet, equipment, cable shields, and so on, and power supply connection are covered in the general setup instructions above. In addition to that, make the following connections of functions when appropriate:

- Run/Alarm relay
- Power supply supervision
  (see Section 2.2.10.3, Supervision for Power Supply Module SA610).

The location of the connections within the cabinet are specified in the terminal diagram form enclosed at delivery.

Run/Alarm Relay



Pin 2. common
Pin 3: normally open
Pin 1: normally closed

normal: Processor Module is operational
shown: deenergized, Processor Module not operational

Configuration: not necessary

Figure 2-22. Connection of Run/Alarm Relay

Preparation for Start-up

Please see the general checklists in Section 2.2.19, Checklists.

2.2.13 Bus Extension to S600 I/O

You can use the following basic information when you install an electrical bus extension.

Assembly

The different parts of the bus extension are mainly factory assembled. These include:

- Bus extender module(s) CI615 in the basic station
- Bus extender module(s) CI610, each located in separate I/O stations
- Bus extension cables connecting subracks within a cabinet.

You are supposed to make the interconnection of the bus extension between cabinets. Cabinets should be erected side by side in a designated order. Ribbon cables with adapted lengths are enclosed at delivery. **Use these cables!**
It is important not to exceed the maximum bus length 20 m, that is, the total length of the cables used may not exceed 20 m.

Check that a plug-in bus terminator TC610 is located only on the last bus extender module in the chain. See Figure 2-23.

Electric Installation

Make use of the enclosed bus extension cables to interconnect the bus between the cabinets. Such a cable is connected at one end and temporarily wound up and hung up on the wall side.

Figure 2-23 shows an example of a non redundant installation. The actual bus extension cables are illustrated with a thick line. In case of a redundant configuration extender modules and bus cables are duplicated. Do not mix bus sections between the 2 redundant bus-lines.

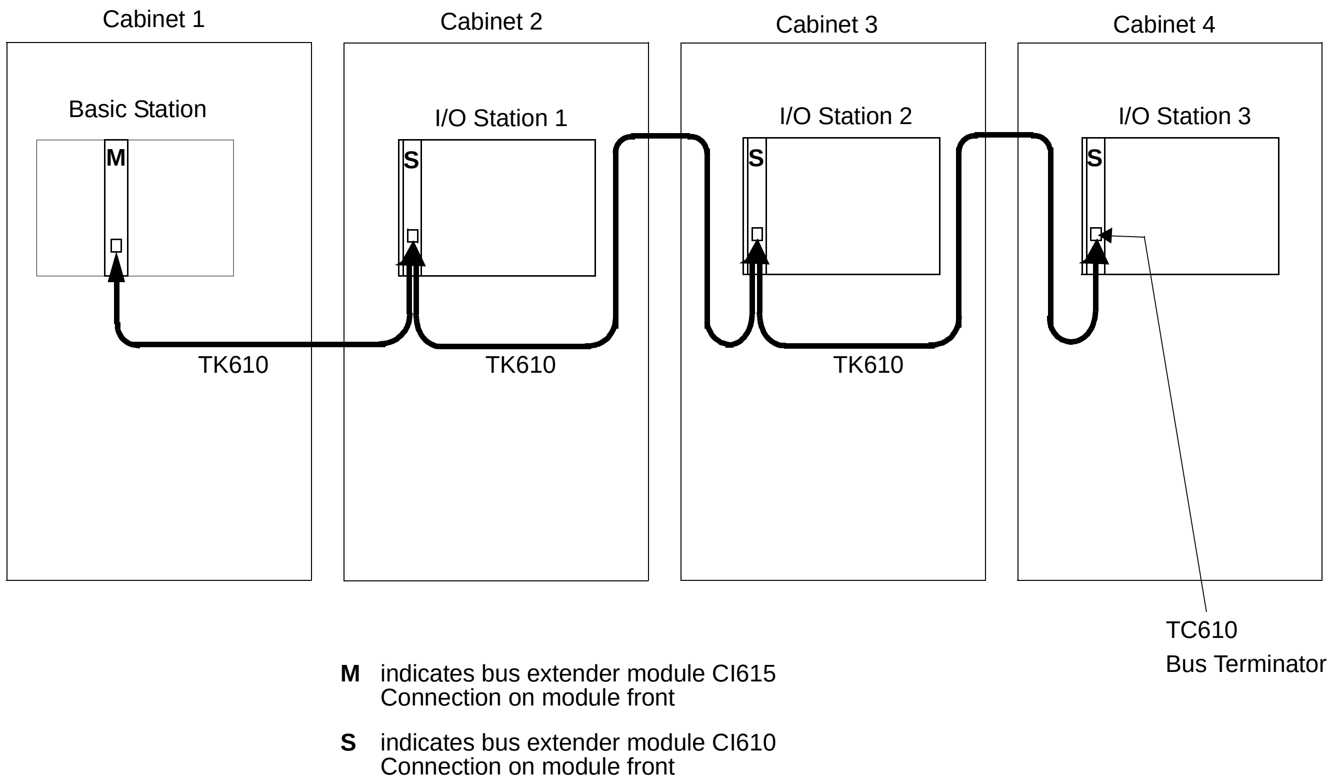

Cabinet 1
Cabinet 2
Cabinet 3
Cabinet 4
Basic Station
I/O Station 1
I/O Station 2
I/O Station 3
M
S
S
S
TK610
TK610
TK610
TC610
Bus Terminator
M indicates bus extender module CI615
Connection on module front
S indicates bus extender module CI610
Connection on module front

Figure 2-23. Example of Bus Extension (Non redundant Configuration)

Since no intermediate side walls or plates are used on a cabinet within a row, install the bus extension cables directly between the cabinets.

The bus extension cables are sensitive to interference. Locate them at least 100 mm away from other cables and wires in the cabinet.

Ensure that there is no tension in the wiring.

Carefully fix the bus extension cables to fixing bars or something similar with the help of cable straps.

In order to minimize the RF emission radiated by Advant Controller 160, the bus extension cables shall be installed so that they have a distance from the CPU connection cables (TK661, TK662) of at least 200 mm. The bus extension cable shall not pass the Processor Modules through the cable duct directly below them.

If for some reason the cabinets are not erected side by side then the bus extension cable must be routed separated from other cables (> 100 mm). A CE-marked design put the requirement that the extension cable shield is additionally grounded by the cable clamp in the cabinet floor.

Preparation for Start-up

Please see the general checklist in Section 2.2.19, Checklists.

2.2.14 S600 I/O

2.2.14.1 Modules

S600 I/O modules are to be located within the subracks of Advant Controller 160 (see Section 2.2.14.2, Assembly).

A module comprises steel plates joined together to form a box. A module contains a PCB with all the electronic circuits needed to carry out the specified function, the connector to the backplane bus in the subrack (see Figure 2-32), and the connector for the process cables or communication cables (see Figure 2-24).

The metallic enclosure of the modules protects the electronics.

All connectors for process signals and communication cables are accessible from the front. The connectors are mounted behind the hinged front door of the modules. You must open the front door to gain access to the connectors. You will find a terminal diagram showing the signal connections on the inside of the front door.

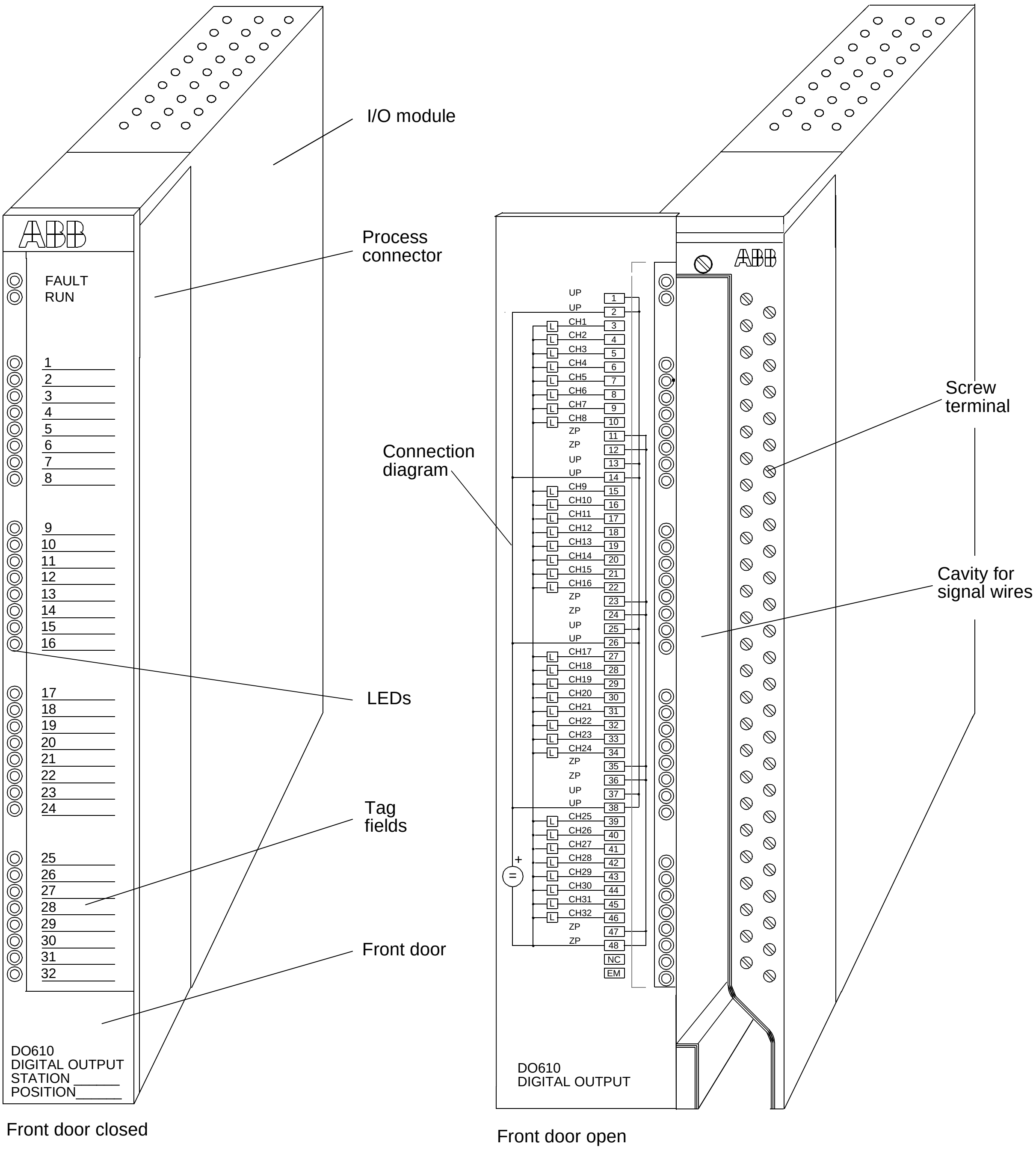
The I/O signals are connected to the process connector. There are two different versions of the process connector: one with screw terminals and one with crimp terminals with cables with loose ends (shielded or unshielded cables).

You can remove the process connector while the process signals are active. Then you can replace an I/O module. A module automatically ceases to function when the process connector is removed.

The status of the module and the process signals is indicated by LEDs on the front. Each module has a green LED RUN and a red LED FAULT. The LED RUN indicates that the module is in operation. The LED FAULT indicates that the diagnostic function has detected a defect in the module.

There is a paper strip on the front door for marking the functions of the LED indicators and the process signals. The module type and the channel numbers are already printed on the paper strip. You can add text for each of the channels. The paper strip also includes space for the station number and position number of the module, to ensure that the strips are attached to the right module.

The enclosure has openings on the top and bottom for ventilation. The enclosure complies with protection class IP 20 according to IEC 529 (equal to NEMA 1).



Front door closed

Front door open

Figure 2-24. I/O Module with Process Connector

Process connectors

S600 I/O modules are connected to the process by a connector located on the front of the module. There are two types of process connectors:

- Process connectors with preassembled process cables (TK630, TK640)
- Process connectors with screw terminals (TF620).

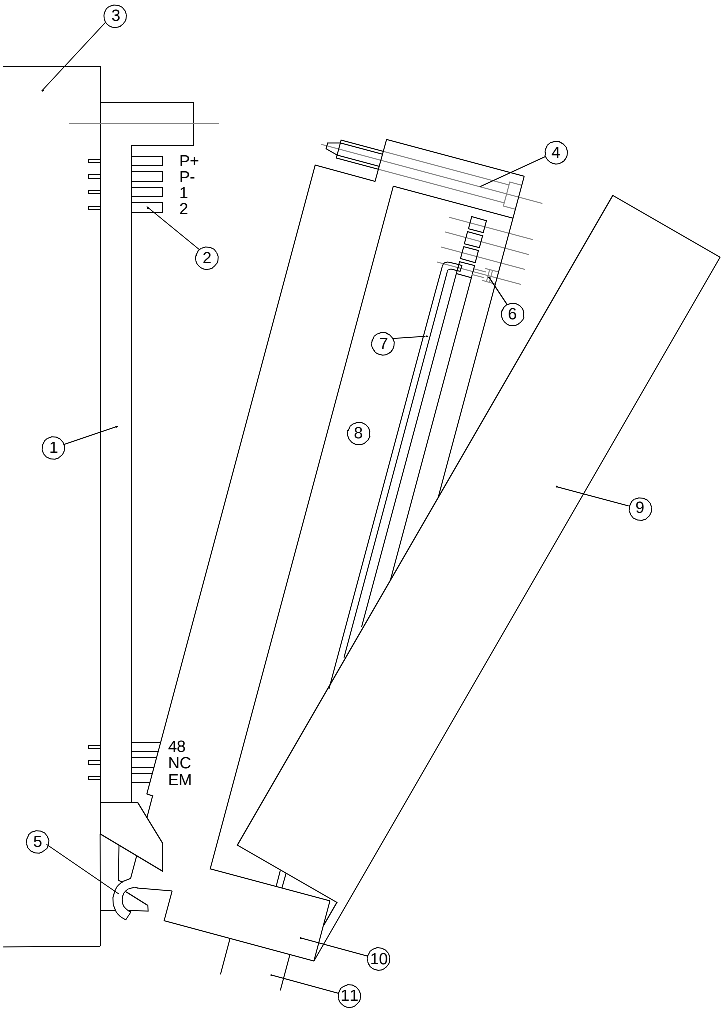
Preassembled process cables are fitted with a connector with crimp terminals.

Process connectors with screw terminals

The designation of the connector with screw terminals is TF620. The connector has 52 contacts, 50 of which are accessible and have screw terminals. The two uppermost contacts, marked P+ and P-, are connected by a wire jumper in order to detect if the process connector is connected. These contacts are not accessible. Up to 48 of the screw terminal contacts are used for process signals. One contact is used for connecting a cable shield (EM) and one contact is not used (NC).

The screw terminals can accommodate wire gauges from 0.5 mm^2 to 1.5 mm^2. For a small number of terminals the maximum wire gauge 2.6 mm^2 is applicable, for example for power supply connections. The connector's cavity for the cable has a dimension of 24 × 40 mm. The cable can be clamped with two nylon straps. The wire entrance part of the connector has a dimension of 16 × 40 mm^2.

The connector is supplied with a cover fitted over the contacts, making it safe for high-voltage use.



① Multipoint connector plug (part of module)
② Blade contact
③ PC board of the I/O module
④ Fixing screw of for multipoint connector
⑤ Hook
⑥ Screw
⑦ Process cables
⑧ Space for process cables
⑨ Cover
⑩ Pivot
⑪ Process cable

Figure 2-25. Process Connector with Screw Terminals

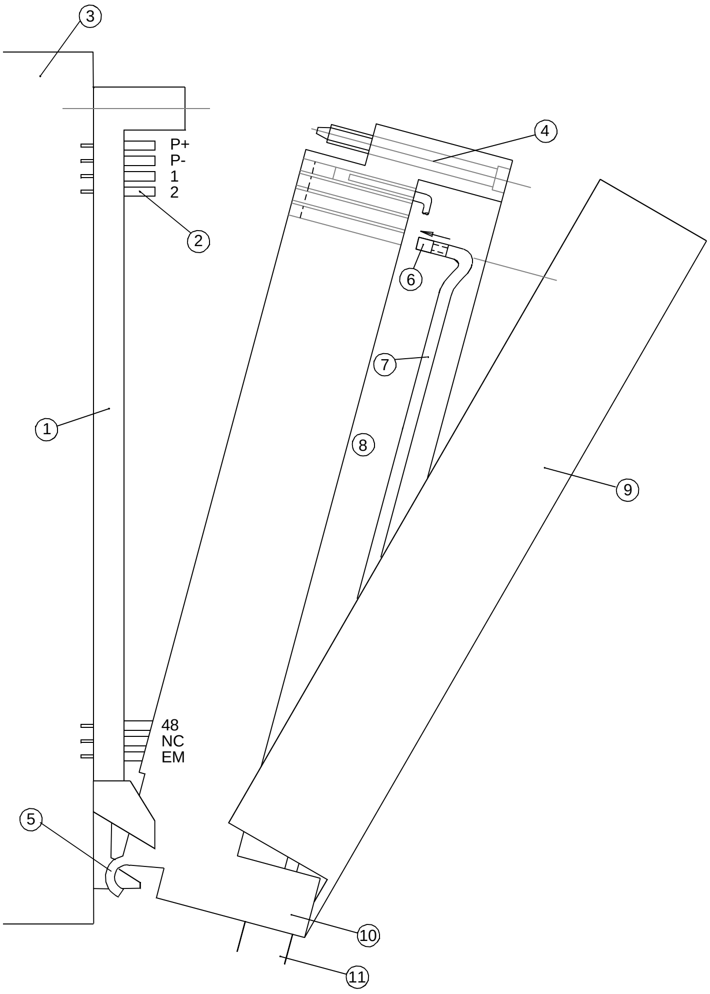
Process connectors with cable

The designation of the process connectors with prefabricated cable are TK630 and TK640. TK630 comprises a process connector type TF610 and an unshielded process cable. TK640 comprises a process connector TF610 and a shielded process cable. The connectors can be supplied with three different cable lengths of 3.0, 5.0 and 10.0 meters. The cables are connected to the process connector's crimp contacts and are clamped in the cable entrance of the connector by a nylon cable strap. The other end of the cable is simply cut off, that is, without any preparation.
As you can see from the specification below, the wires are numbered along their whole length, so that the cable can be cut to any length without losing the wire identification.
The cable has 48 wires conforming to the following specification:

- AWG20, 48 × 0.56 mm^2 gauge wires, each wire with seven strands of 0.32 mm, flex class 5
- Black wire isolation
- Wire numbers: 1 to 48
- Shield connected to EM (only TK640)
- Wire identification: Each wire has its own number printed along the wire
- Color of sheathing: Grey RAL7035
- Cable flammability: UL-CL2
- Minimum bending radius: Approx. 5× cable diameter
- Rated isolation voltage: 300 V.

Table 2-3. Process Connectors and Cables

Description	Type
Process connector, screw terminals, maximum wire gauge 1.5 mm^2	TF620
Process connector with cable, 3.0 meters, wire gauge 0.56 mm^2, unshielded	TK630V025
Process connector with cable, 5 meters, wire gauge 0.56 mm^2, unshielded	TK630V050
Process connector with cable, 10 meters, wire gauge 0.56 mm^2, unshielded	TK630V110
Process connector with cable, 3.0 meters, wire gauge 0.56 mm^2, shielded	TK640V030
Process connector with cable, 5 meters, wire gauge 0.56 mm^2, shielded	TK640V050
Process connector with cable, 10 meters, wire gauge 0.56 mm^2, shielded	TK640V110



① Multipoint connector plug (part of module)
② Blade contact
③ PC board of the I/O module
④ Fixing screw for multipoint connector
⑤ Hook
⑥ Junior timer contact
⑦ Process cables
⑧ Space for process cables
⑨ Cover
⑩ Pivot
⑪ Process cable

Figure 2-26. Process Connector with Crimp Terminals

Information on the module front, Tag fields for I/O signals

You can find the following basic information on the front of the module (see also Figure 2-27):

- FAULT, next to the red LED
- RUN, next to the green LED
- Type designation at the bottom.

In addition to this basic information, further explanation about the module may be noted on a paper strip attached to the front door. The paper strip is covered with a transparent lid to prevent smudging.

There is a standard preprinted strip for each module. On it, the channel numbers are printed at the same height as the corresponding LED, making it easy to find the signal belonging to a particular channel.

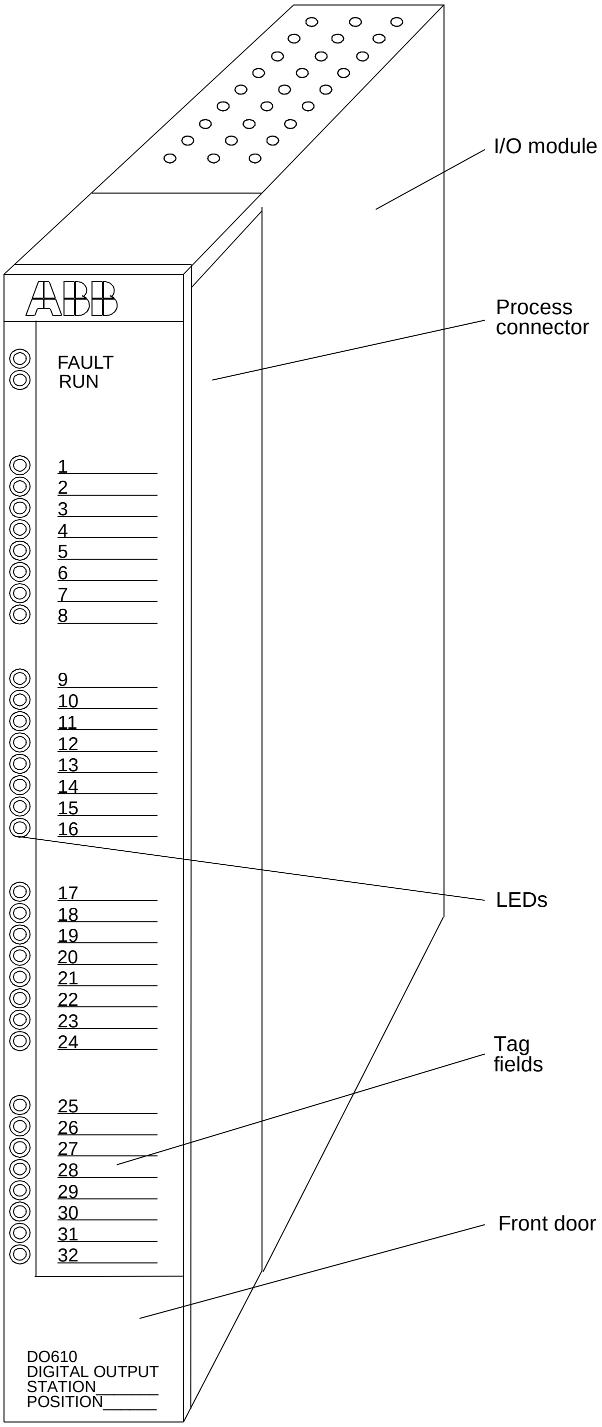


Figure 2-27. I/O Module with Front Door Closed

Information on the module front, Connection diagram

There is a standard scheme for allocating available process connector terminals to process signals. To simplify wiring the I/O system during installation, a connection diagram is engraved on the inside of the module front door. The diagram shows schematics, the process power supplies and the relationship between process channels and connector terminals (UP, ZP and channel/terminal number).

The diagram also shows any internal connections there may be between pins as well as examples of how to connect sensors, actuators, and so on. Apart from the connection diagram, the type designation of the module and a short explanation of its function are engraved on the inside of the front door. The terminal designations on the inside of the front door have the same spacing as the terminals of the process connector, thereby simplifying wiring and tracing connections.

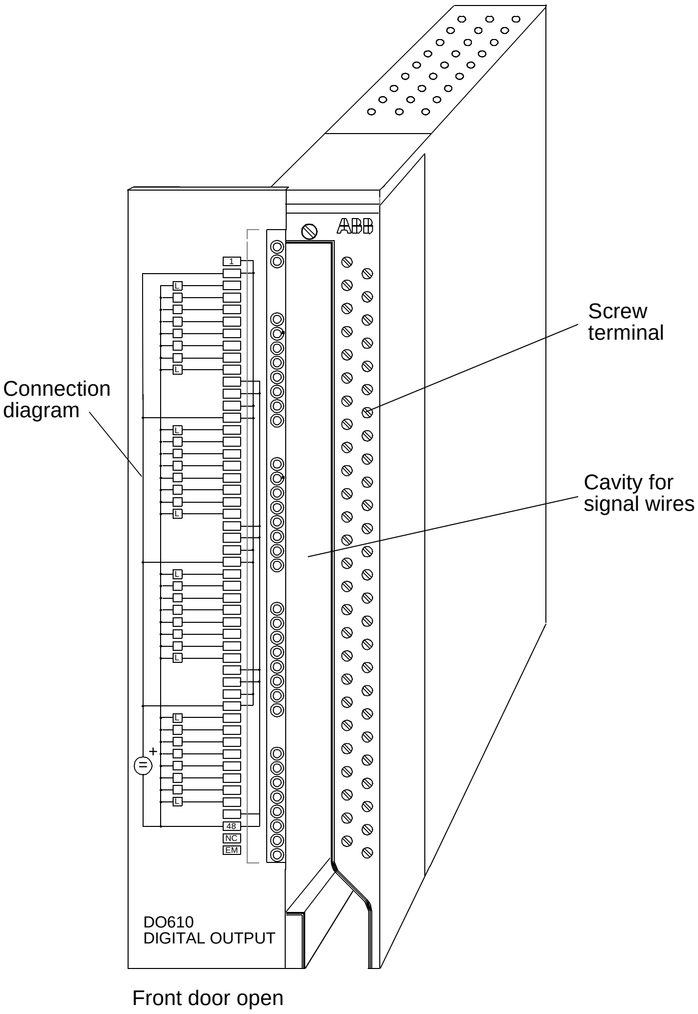


Figure 2-28. I/O Module with Front Door Open

2.2.14.2 Assembly

General

S600 modules and terminal units are normally factory assembled. For information regarding the location of equipment, see the actual delivery documentation. Assembly drawings, for example, also give the cross-reference between the following structures:

- Physical location of modules (position of modules in subrack) and terminal units
- Functional item designation of modules and signal channels.

The functional item designation, for example, AI1 and the position of a S600 module are hard related to each other. That means, for example analog input module with functional item designation AI1 must be inserted at a certain position in the subrack. The relation to the position of the modules in the subrack is determined by the DB part of the application program.

Initially, standard location is followed, see Section 2.1.4, Standard Layout and Disposition of Cabinets. Customized layout is possible whenever applicable.

Reorganization of modules and terminal units is “theoretically” possible. A module position can be changed if the specified position is also changed in the DB part of the application program.

The question is, are there sufficient cable lengths to do the work.
A reorganization also calls for changing the documentation of the equipment.

Subracks

The subrack and cable duct assembly for Advant Controller 160 will fit in a cabinet with a 19-inch rack conforming to IEC 297-1. The design is not confined to any particular cabinet and the minimum size is determined by the number of cables and marshalling.

There are three types of subracks, the basic subrack of the basic station RF616, the basic subrack of the I/O station RF615 and the extension subrack RF620.

The three subracks have the same dimensions. They have a width of 482 mm, which conforms to the 19-inch standard, and a depth of 325 mm, so you can install them in a cabinet 400 mm deep (internal depth not less than 330 mm). The height of the subracks themselves is 269 mm. The cable duct RC610 adds a further 100 mm to the height. In order to insert and withdraw I/O modules, a minimum space of 120 mm above the subrack is required. You should also leave a space of 120 mm below the subrack for ventilation purposes.

The RF616 respectively RF615 and RF620 subracks are designed for installation one above the other. To install them one above the other, leave a 120 mm space between the two subracks, in addition to the spaces above the upper one and below the lower one. The resulting total height requirement is 1100 mm. All cables and mounting accessories are designed for subracks installed one above the other. Side-by-side or back-to-back mounting is not possible.

For more information about dimensions see Section 3.2.9, Mechanics.

Basic Subrack RF616

The RF616 is the primary subrack to use in a basic station. It has dedicated positions for the Processor Modules (PM640, PM644, PM645 and PM646), the Communication Interfaces CI630, CI631, CI626 and CI627 (communication with Advant Fieldbus 100), and power supply modules SA610. A code switch for setting the station address of the controller on the main Advant Fieldbus 100 is located on the left-hand side of the basic subrack.

NOTE

> For controllers with redundant CI630/CI631 only Advant Fieldbus 100 station addresses 1 to 47 are allowed.

The subrack has 10 positions. Free slots can be used for 1 carrier module SC610, I/O modules and for 1 or 2 bus extender modules CI615. The basic subrack RF616 can for example accommodate 2 redundant Processor Modules PM645/PM646, two redundant Communication Interfaces CI630 and 6 I/O modules or—if two power supply modules SA610 are used—4 I/O modules.
A 25-pole sub-D bus connector for an extension subrack is also located on the left-hand side of the basic subrack. On the right-hand side, there are four terminals (USA/ZD, USB/ZD) for the 24 VDC station voltage power supply.

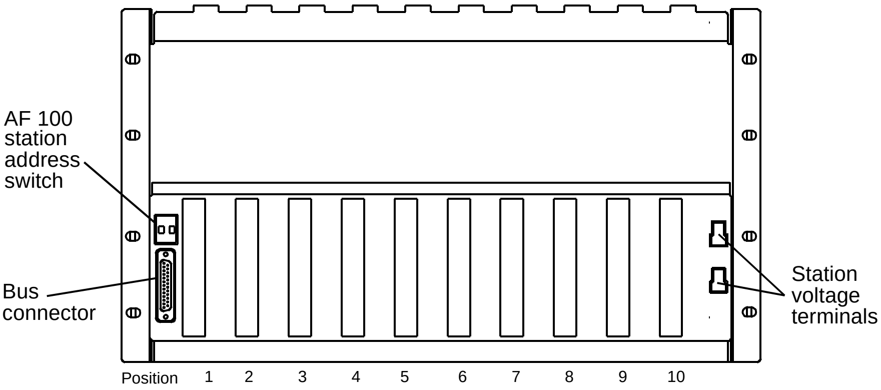


Figure 2-29. Basic Subrack RF616 for Basic Station

Position 1: Second CI630 for redundant communication (option)
Position 2: Communication Interface CI630 or CI626 (mandatory)
Position 3–8: Processor Modules PM640, PM644, PM645 and PM646 (1 PM is mandatory)
Position 9–10: Power supply module SA610 (option)
Unused slots 3–10: I/O modules, 1 submodule carrier SC610 (1), 1or 2 bus extenders CI615 (all optional).

Basic Subrack RF615

The RF615 is the primary subrack to use in an I/O station. It has dedicated positions for bus extender modules CI610 and power supply modules SA610. A code switch for setting the I/O station address is located on the left-hand side of the basic subrack. The subrack has 10 positions. so it can accommodate two redundant CI610 and 8 I/O modules or—if two power supply modules SA610 are used—6 I/O modules. A 25-pole sub-D bus connector for an extension subrack is also located on the left-hand side of the basic subrack. On the right-hand side, there are four terminals (USA/ZD, USB/ZD) for the 24 VDC station voltage power supply.

---

(1) Only 1 SC610 per controller altogether

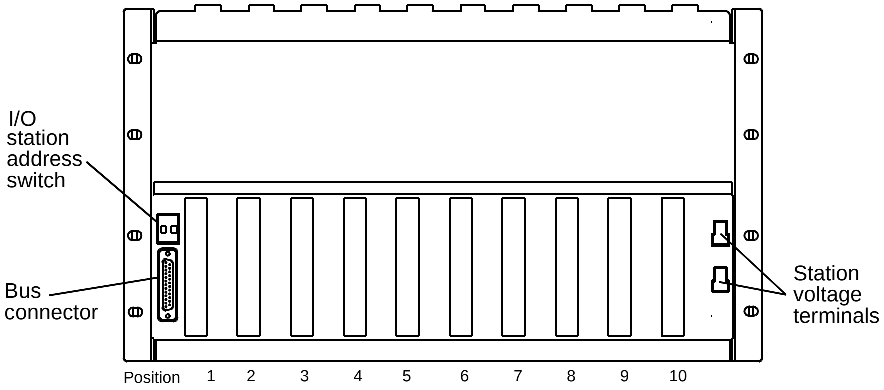


Figure 2-30. Basic Subrack RF615 for I/O

Position 1–2: 1 or 2 bus extenders CI610 (1 CI610 in position 1 is mandatory)
Position 9–10: Power supply modules SA610 (option)
Unused slots 2-10:I/O modules, 1 submodule carrier SC610 (1) (all optional)

Extension Subrack RF620

The RF620 is an optional extension subrack only usable for I/O modules, 1 submodule carrier SC610 and power supply modules SA610. On the left-hand side of the extension subrack, there is a 25-pole sub-D connector for the bus connection to a basic subrack.
The extension subrack has 10 positions and 10 additional modules can be fitted.

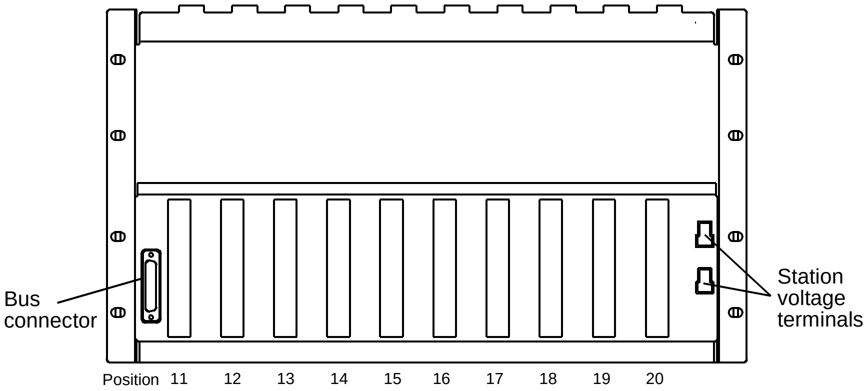


Figure 2-31. Extension Subrack RF620 for Base or I/O Station

---

(1) Only 1 SC610 per controller altogether

Position 9–10:	Power supply modules SA610 (option)
All slots 1–10:	I/O modules, 1 submodule carrier SC610 [1] (all optional)

I/O Module

To mount a module on the subrack, hook it onto the upper front edge of the subrack, swing it down to the vertical position and screw in the module fixing screw (see Figure 2-32).
This screwing action ensures that the pins of the bus connector make in the proper sequence and that the module starts up correctly. The mechanical connection to the subrack grounds the module enclosure and provides EMC performance.

The process connector and the cables to the module are covered by a front door (see Figure 2-28).

Enclosure protection class of the S600 I/O modules: IP 20.

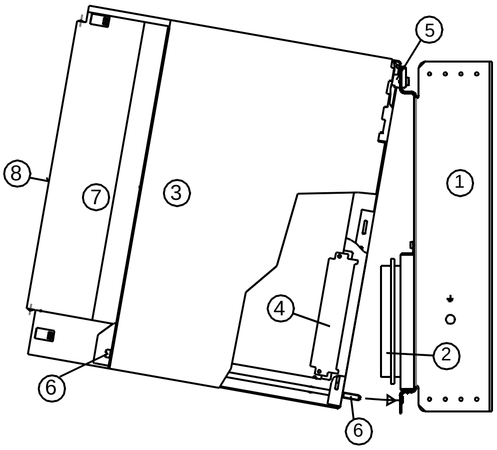


Figure 2-32. Module Fixing Screw when Mounting the Module on the Subrack

1) Subrack	2) Bus connector subrack
3) Module	4) Bus connector module
5) Hook	6) Module fixing screw
7) Space for process connector	8) Front of module

---

[1] Only 1 SC610 per controller altogether

Submodule Carrier SC610 and Submodules CI532

Submodule carriers are modules which contain slots for submodules to connect to the backplane. Submodule carrier modules have no complete function. You can obtain the desired functionality by mounting the respective submodules into the carrier module. This is illustrated in Figure 2-33.

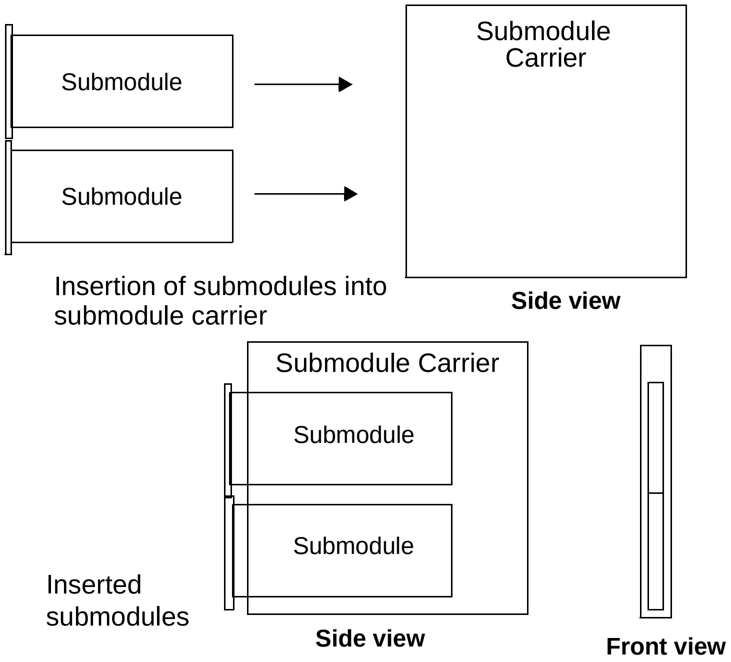


Figure 2-33. Carrier Module SC610 and Submodule CI532 Mechanics

One submodule carrier can house two submodules.

In principle, the one submodule is independent of the other submodule. This means you can insert, start, stop and remove the one submodule without affecting the other submodule.

The submodule carrier is a single point of failure. Damaging the carrier module may affect one or both submodules. Replacing the carrier module, however, obviously affects both submodules.

Mechanically, any submodule fits into any submodule position on Advant Controller 160. The software does not, however, necessarily support all combinations. For the supported submodules please see Section 3.1.5.1, Provided Link Types.

Process Connectors

You can mount the process connector socket on the front of the module by hooking it into the lower edge of the module and swinging it upwards towards the module until the fixing screw engages and can be tightened. As with the module fixing screw, this action also ensures a proper start-up sequence, since the making order of the last two contacts P+ and P- is used to determine whether or not the process connector is mounted.

Two types of process connectors are available (see Figure 2-25 and Figure 2-26):

- Screw-type terminals (48 process signals, one spare, one chassis ground)
- Crimp-on-snap-in terminals (48 process signals, one spare, one chassis ground).

2.2.14.3 Electric Installation

Process Signals

Process signals are connected to the connection units according to site installation drawings supported by:

- Assembly drawings enclosed at delivery
- Terminal diagram forms enclosed at delivery
- Connection examples in *S600 I/O Hardware Reference Manual* and *S600 I/O hardware Advant Controller 160 Reference Manual.*

The following instructions apply:

- Cable routing in cabinets, see Section 2.2.8, Cable Routing in Cabinets
- Grounding of cable shields, see Section 2.2.7, Grounding
- Grounding of process signals, see Section 2.2.7, Grounding.

Regarding cable selection, external cable routing, and so on, see general information in *Interference-free Electronics Design and Applications*. A carefully accomplished electric installation is the basis of future interference-free operation.

NOTE

Unused supervised analog inputs (AI) must be terminated in order to avoid respective error messages.

2.2.14.4 Preparation for Start-up

Check of the External Wiring

Judge the level of workmanship case by case. The result determines the need to thoroughly check all connections before the system is powered up. You can, of course, check with a buzzer or similar device that the external wiring to the process equipment is correct and that all conductors are intact.

Without activating the control equipment, you can also check that transducers and actuators (including all process wiring) function correctly. This makes it necessary to connect voltage to these units and develop suitable checking methods, which are time-consuming activities.

An alternative method is to make an integrated check of the process equipment and wiring and the corresponding controller function, which can be accomplished with a circuit-by-circuit procedure. Preferably, the controller is loaded with an application program. The DB part of the application program is then used as one checkpoint. Status/values can be read and control signals to process objects can be simulated by an Engineering Station.

CAUTION

When you use a somewhat tougher method, be aware of the risk of “accidents.” Short-circuit and over-voltage can damage a limited part of the equipment, for example, a process I/O module.

2.2.15 S800 I/O

S800 I/O modules are normally delivered separately, to be erected in suitable cabinetry on site. The necessary communication modules and modems are assembled in the controller cabinet. For information regarding the location of this equipment, see the actual delivery documentation. For other information, including all questions of installation, see the separate documentation:

- *Advant Fieldbus 100 User’s Guide*

and

- *S800 I/O User’s Guide*

Preparation for Start-up

The general information given for a check of external wiring applies.

2.2.16 Panels

MODBUS Panel Connections

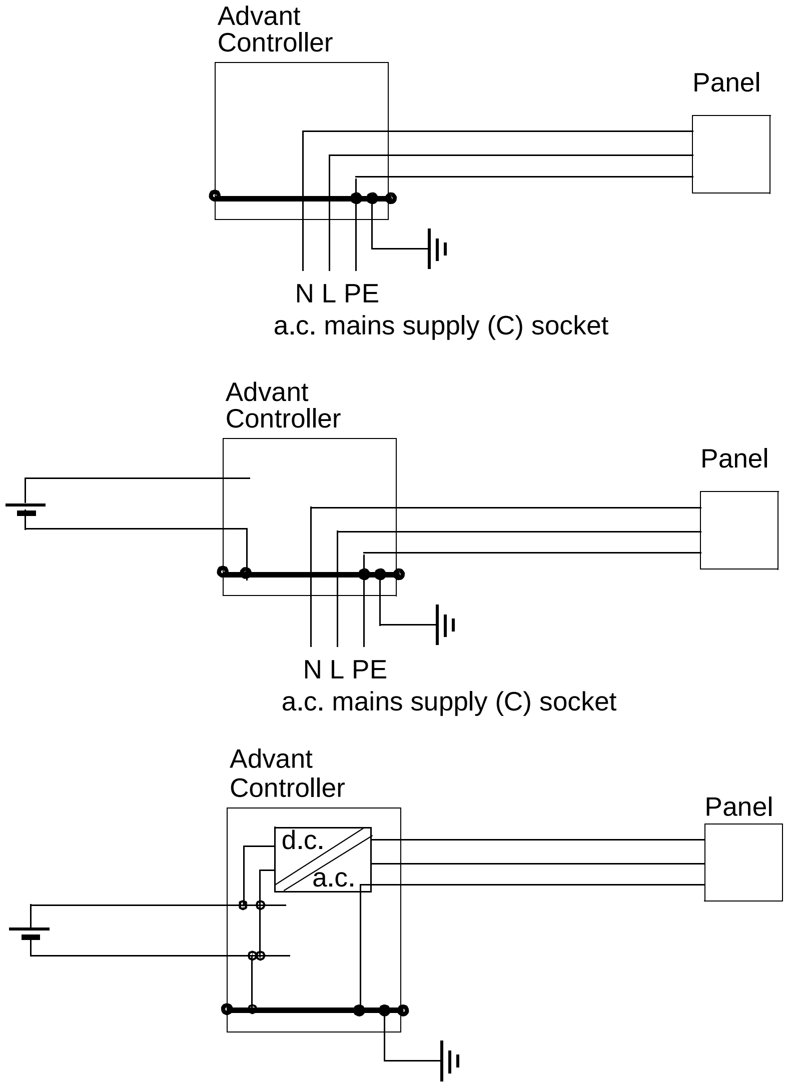
How to connect a panel using the MODBUS protocol is described in the *MODBUS Panel Connections Advant Controller 100 Series, User’s Guide*.

Power Supply

It is recommended to use a serial interface with modem for connection of a panel. A separate a.c. supply voltage is to be applied.

If you do not use a modem, you must take an a.c. voltage supply with a protected earth (PE) from the Advant Controller cabinet, that is, it is not acceptable to use the closest or otherwise most convenient supply receptacle.

Make the connection as shown in Figure 2-34. **The significant aspect is that the peripheral unit should be grounded in the controller protective earth.**



a.c. powered controller

d.c. powered controller
a.c. is available

d.c. powered controller
no a.c. available

Figure 2-34. Supply of a Panel Without Modem

You are directed to always check that the utilized a.c. power supply meets the quality requirements of the panel, for example, the class of the network.

Take into consideration the extra load caused by any peripheral unit:

- When an intermediate isolating transformer is used in the cabinet to convert a two-phase network to a single-phase network
- From a fusing viewpoint.

Given the above rules, you can use any spare power outlet in the cabinet or you can arrange for an additional branching socket.

2.2.17 Communication

Please refer to the following separate documentation:

- User's guide for the actual communication link
- Assembly drawings, terminal diagram forms, and so on, enclosed at delivery of the Advant Controller. These show you the location of the hardware.

The following instructions apply:

- Cable routing in cabinets, see Section 2.2.8, Cable Routing in Cabinets
- Grounding of cable shields, see Section 2.2.7, Grounding.

Regarding cable selection, external cable routing, and so on, see general information in *Interference-free Electronics Design and Applications*.
A carefully accomplished electric installation is the basis of future interference-free operation.

NOTE

At least one Communication Interface CI626 or CI630 is mandatory with terminators connected even if no Advant Controller 100 communication is required.

2.2.18 Engineering Station

The following apply to Advant Station 100 Series Engineering Station when connected directly to Advant Controller 160.

Electric Installation (including Power Supply).

Plug the communication cable enclosed with the Engineering Station into the connector **Com A** on the Processor Module front plate.

From the viewpoint of Advant Controller, there are no restrictions on the mains power supply of the Engineering Station, for example, no requirement of earthing and same supply, and so on. The controller and the Engineering Station are galvanically isolated from each other by the serial Communication Interface.

2.2.19 Checklists

This Chapter contains a condensed form of the detailed information given in Chapter 2, Installation. References are made to each chapter.

In the setup instructions, you are occasionally referred to a separate document, *Interference-free Electronics Design and Applications*.
The following checklist is a summary of important information addressed to the actual Advant Controller 160.

2.2.19.1 Grounding Philosophy, Earthing Line System

(Refer to Section 2.1.3, Electromagnetic Compatibility, Section 2.1.11, Lightning Strike Protection, Section 2.2.7, Grounding).

Table 2-4. Grounding Philosophy, Earthing Line System

Item	Concerning	Action
Grounding philosophy	Ground system	Grounding only to power earth line network. Only one ground system. No exceptions.
Earth line system	Design	The earth line system of the installation must be carefully installed and must incorporate the switchgear

2.2.19.2 Process Cabling, Shielding, Grounding, maximum Length

(Refer to Section 2.2.7, Grounding, Section 2.2.8, Cable Routing in Cabinets and Section 2.2.9, Radio-Proof Cabinet).

Table 2-5. Process Cabling, Shielding, Grounding, max. Length

Item	Concerning	Action
Cables	Prescribed type	- Communication cables - Pulse transducer cables - Shielded for AI ≥ 12 bit and for Low level AI (Pt, thermocouple) - Same signal types in same cable (low level/d.c./a.c./ communication/power supply) - Signal wire and return wire in same cable
Shielding: Single shield	Grounding: AI, AO, DI, DO, Modem TC562	Same position as signal circuit
	Grounding: Communications pulse transducers	At both ends
Shielding: Double shield	Grounding:	
	Outer shield	Both ends
	Inner shield	As signal circuits
Cable without shield	Grounding	All signal circuits grounded at the same end
a.c. digital inputs 120 V/230 V	Max. cable length	Approx.: 115 V – 230 m 230 V – 115 m
Shield connections in radio-proof cabinet	Connection	Cable shields which are grounded in the cabinet must be immediately grounded directly or via capacitor when they enter the cabinet (See separate instructions)
Shielded cables not grounded in the radio-proof cabinet	Connection	Capacitive decoupling is to be used in the cabinet. Or a cable with double shield can be used where the outer shield is grounded in the cabinet.

2.2.19.3 Supply

(Refer to Section 2.2.7, Grounding, Section 2.2.8, Cable Routing in Cabinets and Section 2.2.9, Radio-Proof Cabinet).

Table 2-6. Supply

Item	Concerning	Action
a.c. Mains	Connection in cabinet	Phase **(check for correct voltage)** Return Protective earth (if distributed) **Note:** There must be no breaks in the protective earth line before the connection to the PE terminal
	Fuse	In phase (phases)
	Connection of network:	No unsuppressed load on same finale circuit from distribution box
	Using of interference-sensitive power supply units not manufactured by ABB	Special isolation transformer for electronics supply must be used
	Internal distribution	Incoming power supply (120 V/230 V) must be separated from other cables by 5 cm or more
d.c. (floating battery)	Earthing, supply	Negative pole to PE terminal of cabinet directly at entry to cabinet
d.c. (earthed battery)	Connection	Via d.c./d.c. converter
Subrack supply	Max. power output	< 90% of stabilizer capacity

2.2.19.4 Lightning Protection

(Refer to Section 2.1.11, Lightning Strike Protection).

Table 2-7. Lightning Protection

Item	Concerning	Action
Lightning protection	Protection	Actions are compulsory for all circuits in: Overhead lines Cables above ground Cables that leave the general earth line network

2.2.19.5 Subrack, Connection, Module

Table 2-8. Subrack, Connection, Module

Item	Concerning	Action
Connection	Quality	Only correctly made, screwed or clamped connections are approved **Note**: Inspected and approved tools must be used
Modules	Variant reference	Check for lowest revision approved variant to be used for the equipment and use replacement of the same or higher revision number. This item is mainly relevant to maintenance and use of spare parts.
Modules	Assembly	Check that all units located in subracks are properly inserted.
Analog input modules	Full accuracy in the frequency range	Check data sheet in *S600 I/O Hardware Reference Manual*

2.2.19.6 Cabinet, Internal Cables

(Refer to Chapter 2, Installation).

Table 2-9. Cabinets, Internal Cables

Item	Concerning	Action
Metallic door with glass window	Shielding	Interference immunity for the particular frequency which will be used, must be verified by a relevant walkie-talkie. **Not** allowed within EEC, EFTA. Not a CE-marked design.
Row of cabinets	Electrical connection (grounding)	Through short 35 mm^2 copper conductors or horizontal copper rail joining the PE terminals in each cabinet.
Cabinet parts (plates)	All parts electrically connected to each other and to the copper bar Divided cabinets	$R < 100\ m\Omega$ Connection with special screws and nut bars
Earthing in cabinet	Design	Only a single grounding system for Advant Power equipment **NO EXCEPTIONS**

Table 2-9. Cabinets, Internal Cables (Continued)

Item	Concerning	Action
Lighting	At maintenance	Only by filament lamp
Temperature in cabinet	Max. permitted temperature for continued operation.	Max. permitted temperature for continued operation in cabinet is 55 °C. Measured just above the subracks. If this value is exceeded the number of circuit boards must be reduced.
Radio emission	Emission	Where EN or FCC requirements must be met, only radio-proof cabinet is adequate
Shielded cable	Design	Communication, pulse transducers and sensitive analog signals be shielded up to the front connector
Internal cables	Routing	See: Section 2.2.8, Cable Routing in Cabinets. Check that there is no tension in the wiring.

2.2.19.7 External Cables

When you are selecting suitable cables to use and when the cables are placed in the plant, be aware that there are some restrictions and rules to be followed which involve, among other things:

- The distance between Advant OCS cables and non-Advant OCS cables
- The routing of communication cables
- Mixing of signals and signal types within cables
- The need for shielded cables.

See the electrical installation rules given in the sections above and the general document *Interference-free Electronics Design and Applications*, which also gives examples of the available cables.

2.2.19.8 Communication, Communication Cables

(Refer to Section 2.1.5, Grounding and Section 2.2.7, Grounding).

Table 2-10. Communication, Communication Cables

Item	Concerning	Action
Communication cables with shield (not coaxial cables)	Electrical connection to chassis Max. permitted length	≤ 50 mm (1.9 inch.) (1) Max. specified length must not be exceeded
Coaxial communication cables	Electrical connection to chassis Max. length	Not to be directly earthed or earthed at one point only Max. specified length must not be exceeded
Communication without modem	Routing of cables	More than 100 mm (3.9 inch.) away from other cables

(1) Special rules apply to a CE-marked design. Refer to Section 2.2.7.5, Grounding of Communication Cable Shields

2.2.19.9 Corrosive Gases

Table 2-11. Corrosive Gases

Gas		Value (max.)
Sulphur dioxide	SO_2	30 ppb
Hydrogen sulfides	H_2S	10 ppb
Nitric oxides	NO_X	30 ppb
Chlorine + hydrogen chlorides	CL_2 + HCL	10 ppb
Hydrogen fluorides	HF	10 ppb
Ammonia	NH_3	500 ppb
Ozone	O_3	5 ppb

NOTE

If corrosive gases appear in the air, the humidity must be less than 40 percent, the rate of change of humidity less than 0.1% unit/minimum and the maximum temperature less than 40 °C.

The copper corrosion is to be a maximum of 300 Å/28 days.

2.2.19.10 Miscellaneous

Table 2-12. Miscellaneous

Item	Concerning	Action
Relays and contactors in cabinets	Suppression	Cabling to non-suppressed inductive loads in Advant OCS cabinets must be kept more than 100 mm away from internal cables
Analog inputs/outputs	Type	Correct type: For grounded transmitters/ actuators/loads the inputs/outputs must be differential or isolated

2.2.20 Final Procedures Before Start-up

Remove all debris remaining from the work performed and clean off all grease and dirt. Check that no tools or assembly materials are left in the cabinets. Vacuum cleans the cabinets.

2.3 Shut-down Procedures

Before power supply switch-on and start-up of the equipment, it is important that you know how to shut down in different situations. See below.

Necessary Outfit

No special kit needed.

2.3.1 Safety Regulations

The instructions given in Section 2.2.1, Safety Regulations are applicable in all situations when you work with an Advant Controller and associated equipment. Please read the instructions carefully. One instruction is highlighted:

DANGER

Work with care when supply voltage is applied in the system. The voltage in the cabinet can cause injury and can even kill a human being.

2.3.2 Controller and I/O

Emergency Shut-down

An emergency stop should always be available. Adapt it to local statutory regulations. This is an obligation of those responsible for the plant design and construction. The controller system does not supply this specially arranged function.

NOTE

Check the location of the emergency stop and use it in an emergency situation.

From an electrical and functional viewpoint, an emergency stop has the same consequences to the controller and attached equipment as a safety shut-down. See below.

Safety Shut-down

The controller and its S600 I/O mounted in a row of joined cabinets are, from the mains power supply viewpoint, an entity. Safety shut-down aimed at disconnecting the controller from the mains is carried out in two ways:

- As prescribed in the site planning section, Section 2.1.7, Power Supply and Fusing, there should be a common safety switch installed within 3 m from the cabinets.

  NOTE

  Check the location of the safety switch and use it when working with the equipment.

  The safety switch should shut down the power supply of not only the electronics system but also the adequate transducers and other process objects. In other words, a total power shut-down for the plant section controlled. Since the safety switch is a plant component, this document cannot stipulate and describe the design exactly. Please check the plant documentation in this respect carefully. Instructions indicating the extent of the power supply shut-down should be attached to the safety switch.

- You can also create a selective power shut-down of the entire electronics system using the mains circuit breaker in the lower part of the cabinet where the controller basic station resides.
  The breaker is labeled S1. This circuit breaker sometimes also disconnects the field equipment supply for the plant.

  NOTE

  Sometimes there exist several breakers. See Section 2.2.10, Power Supply Connection.

Regardless of the shut-down method, the results and consequences are:

- – Application program execution immediately stops
- – There is zero output to the process objects (see below “output set as predetermined”)
- – Output relays are de-energized (see below “output set as predetermined”)
- – The system software and the application program are secured against loss of power within the Flash PROM of the Processor Modules
- – The error messages within the error buffers of the Processor Modules are secured for at least 24 hours against loss of power through a gold capacitor
- – The system is ready for a restart. You perform a restart by operating the actual mains switch when the cause for the shut-down is resolved.

S600 I/O

A central shut-down (impact on the whole controller including all I/O stations) causes all S600 I/O outputs to go to zero. At local shut-down (for example impact only on one I/O station) the S600 I/O outputs of the "central" basic station are not disturbed.

S800 I/O

A central shut-down causes the S800 I/O outputs to **freeze** or go to **predefined** value, as specified at DB element for S800 I/O channel in the application program. A local shut-down causes the S800 I/O outputs to go to zero.

Regarding the output behavior attached to S600 I/O and S800 I/O, please be aware that zero output, etc., is the designed state. It cannot be guaranteed under all conditions, e.g., in the event of a failure.

Manual Stop

Besides the most drastic shut-down method—disconnecting the power supply—other methods of "stopping" the controller are available to you.

You can stop program execution as follows:

- Use the operator's interface on the Processor Module front.
  - Set the MODE selector in STOP position (MODE 0)
  - Press the RES button
  - The result of this stop and its consequences concerning the Processor Module are:
    - the Processor Module immediately **restarts** and the application program execution will stop
    - the Processor Module's on-board outputs are forced to zero
    - output relay signalling a CPU failure is de-energized
    - there is a loss of already read process data.

  NOTE

  - The result of this stop and its consequences concerning the S600 I/O modules depends on the configuration of the controller. See **Output set as predetermined** below.
  - In order to start the application program again you have to download and deblock it with FCB or, if it was saved in Flash PROM before, just set the MODE selector in COLD START position (MODE 1) and press RES button again.
- Use an Engineering Station connected to the controller.
  - Set Command: "Block Program"
  - The result of this stop and its consequences are:
    - application program execution immediately **stops**
    - the outputs remain as before
    - there is no loss of process data (besides what is happening in the process in the meantime).

    In order to start the application program again just deblock it with FCB.

NOTE

In case of safety applications using the PC element PC_DX610 the outputs of the relay module DX610 don't remain as before but will be forced to zero. Additionally the relay on the Processor Module will be de-energized and can be used to switch off the output modules.

Output set as predetermined

In case of a severe controller error, the outputs can be set to predetermined values. This output set as predetermined guarantees integrity of the process in case of controller failures.

NOTE

There is no automatic output set as predetermined. Instead output set as predetermined can be configured with use of the relay outputs of the Processor Modules which are switched over in case of a severe error (see Figure 2-22). Both an open and a closed contact are provided per Processor Module. The relay outputs can be used to switch off the external voltage for digital outputs if the Processor Module which controls theses outputs fails.

Automatic Stop

The reasons for an automatic stop are listed below:

- Loss of power supply
- Fault in power supply
- Fault in Processor Module
- Other fatal error.

The result of an automatic unintentional stop and its consequences are, from the viewpoint of design philosophy, the same as for a safety shut-down you get when pressing RESET button (see above). The Processor Module will execute a COLD START. The controller will stop if MODE selector is in STOP position. For more information about MODE selector and COLD START please see Section 2.4.3.2, Initialization.

2.3.3 Peripheral Equipment

Shut-down of peripheral equipment, is treated from the viewpoint of power supply disconnection only.

Regardless of whether the peripheral equipment is powered common to the controller or from a separate mains, you can shut down by disconnecting the mains whenever necessary. Any faults or disturbances that may occur are local to the peripheral equipment only, for example, a missing printout.
You can restart by switching on the power supply whenever you like with respect to the controller function. The peripheral equipment is self-initialized.

2.4 Start-up Procedures

Activities up through "ready for application program loading" are described in this section. This includes power-up and the first definition/configuration of the system resources. A visible result of the start-up procedures is that all red LEDs on module fronts are turned off and all green LEDs are turned on.

Necessary Outfit

The following kit is a minimum requirement:

- Ordinary hand tools
- Universal instrument, for example, digital multimeter
- Test leads with 4 mm banana contacts and reducer contacts for a 2 mm test jack
- Necessary parts of the documentation listed in Section 1.3, How to Use this Book
- Specific documentation enclosed at delivery, drawings, and so on
- Advant Station 100 Series Engineering Station.

2.4.1 Safety Regulations

The instructions given in Section 2.2.1, Safety Regulations are applicable in all situations when you work with an Advant Controller and associated equipment. Please read the instructions carefully. One instruction is highlighted:

DANGER

Work with care when supply voltage is applied in the system. The voltage in the cabinet can cause injury and can even kill a human being.

Conditions given by "Setup"

If you finish the setup activities by using the checklists given in Section 2.2.19, Checklists, the equipment is almost ready for start. Please read the following security information first.

Measures by Security Means

Power-up of a controller including I/O presents a small but real risk of spurious output signals to the process due to a faulty hardware module. Since this risk is very small, a general safe method, for example, extraction of all output hardware during the first power-up, is not recommended. You are directed, however, to be careful on a case-by-case basis.

Always identify and isolate **critical process objects** in some way if the process is energized. Examples include:

- Opened safety switch
- Disconnected power supply
- Use of disconnectible terminal

- Withdrawn process connectors
- Unplugged terminal block
- Extracted output module.

Perform succeeding operations after power-up, including necessary tests, carefully.

2.4.2 Loading or Upgrading of System Software and its Options

On the front of the Processor Module “PL” will be displayed after power on if no system software is loaded, or “P3” if any system software is loaded and the Start Mode switch is in STOP position. In this case you should load or upgrade the system software and its options as described in this section.

The Advant Controller 160 system software and its options are stored in Flash PROM on the Processor Module.

To load or upgrade either system software or options to flash PROM, you need an Advant Station 100 Series Engineering Station and one of the diskettes listed below:

• AC 160 BASE SW∗2.0/*n*	BASE system software (1)
• AC 160 OPT1 SW∗2.0/*n*	enables the extended PC element set
• AC 160 OPT4 SW∗2.0/*n*	enables the Modbus I driver
• AC 160 OPT6 SW∗2.0/*n*	enables the station redundancy, rotational speed measurement PC elements.

The BASE system software diskette contains the following files:

- README.TXT (Detailed instructions and latest information about the software)
- D005614.PDF (Release Notes in Acrobat Reader format)
- LOADER32.EXE (32-bit Loader for Windows NT 4.0)
- LOADPS.BAT (Batch file to load AC160∗1.2 BASE software)
- LOADCS.BAT (Batch file to load communication software)
- LOADLONG.BAT (Batch file to load option LONG)
- AC16020*n*.IMG (Image file AC160∗2.0/*n* BASE software)
- CSREL2S5.IMG (Image file communication software version 2.5)
- AC16OPLO.IMG (Image file option LONG)

An OPT software diskette contains the following files:

- README.TXT (Detailed instructions and latest information about the software)
- LOADER32.EXE (32-bit Loader for Windows NT 4.0)
- AC160OP*n*.IMG (Image file for OPT*n*)

---

(1) The BASE system software contains OPT2 and OPT3

2.4.2.1 General Hints

If you have three or more Processor Modules in a Basic Station (e.g., CPU redundancy or multiprocessing configurations), it is strongly recommended to load option LONG (long bus time-out) on all Processor Modules. This avoids time-out situations on the Backplane I/O Bus (BIOB).

For Processor Module of type PM640 or PM644 you need to load the BASE software (PS) part and then option LONG.

For Processor Module of type PM645 or PM646 you first need to load the communication (CS) part, then the BASE software (PS) part, and then option LONG.

CAUTION

If you use Processor Modules PM645 or PM646—first check the correct version (2/5) of the communication software (CS) before loading the BASE software. Otherwise the Processor Module may become unusable and must be sent in for repair. If in doubt, load the CS first.

2.4.2.2 Loading or Upgrading the Communication Software (CS Part)

NOTE

This section is only valid for Processor Modules of type PM645 and PM646, not for PM640 or PM644.

Follow this procedure to load or upgrade the communication part of an Advant Controller 160.

1. Connect the Engineering Station to the Processor Module PM645 or PM646 of Advant Controller 160.
2. Use cable 3BDS000111. Connect to serial port COM*n* of your Engineering Station and on the other side use **PS/CS-Converter** and **Com B** of PM645 or PM646.
3. Set **Mode** Selector of the Processor Module to position “0” (STOP).
4. Press the **Res** (reset) button at the front plate of the Processor Module or cycle power.
5. The Processor Module performs a restart without activating its application. The display on the front plate will show “PL” or “P3” (in case of system software is loaded).
6. Insert the diskette containing the AC 160 BASE SW.
7. Use the Windows NT Explorer to browse to the file LOADCS.BAT and execute this file.
8. The loader application starts. Click on <Next>.
9. Click on <User defined> to select COM port and speed manually or check the settings.
10. Click on <Next>.
11. The loader should automatically use the file CSREL2S*n*.IMG (*n* = revision number). Select the serial interface that you have used in step 2.
12. Then click on <Download> to start the load process. Loading of the CS software takes about 2 minutes.

If an error occurs during the download of the system software, repeat the above procedure.

2.4.2.3 Loading or Upgrading the System Software (PS part)

Follow this procedure to load or upgrade the Advant Controller 160 system software:

1. Connect the Engineering Station to the Processor Module of Advant Controller 160.
2. Use cable 3BDS000111. Connect to serial port COM*n* of your Engineering Station and on the other side use **Com B** of the Processor Module.
3. Set **Mode** Selector of the Processor Module to position “0” (STOP).
4. Press the **Res** (reset) button at the front plate of the Processor Module or cycle power.
5. The Processor Module performs a restart without activating its application. The display on the front plate will show “PL” or “P3” (in case of system software is loaded).
6. Insert the diskette containing the AC 160 BASE SW.
7. Use the Windows NT Explorer to browse to the file LOADPS.BAT and execute this file.
8. The loader application starts. Click on <Next>.
9. Click on <User defined> to select COM port and speed manually or check the settings.
10. Click on <Next>.
11. The loader should automatically use the file AC16012*n*.IMG (*n* = revision number). Select the serial interface that you have used in step 2.
12. Then click on <Download> to start the load process. Loading of the PS software takes about 10 minutes.
13. When you have successfully loaded or upgraded the Advant Controller 160 system software, this is indicated on the Engineering Station.

If an error occurs during the download of the system software, repeat the above procedure.

2.4.2.4 Loading or Upgrading an Option

CAUTION

If the option loading or upgrading process is interrupted by either pressing the **Res** button or a power failure, the system software and any previously loaded or upgraded options are erased and must be loaded again. This state of the Processor Module is indicated on its display by showing “PL”.

Follow this procedure to load or upgrade an Advant Controller 160 option:

1. Connect the Engineering Station to the Processor Module of Advant Controller 160.
2. Use cable 3BDS000111. Connect to serial port COM*n* of your Engineering Station and on the other side use **Com B** of the Processor Module.
3. Set **Mode** Selector of the Processor Module to position “0” (STOP).
4. Press the **Res** (reset) button at the front plate of the Processor Module or cycle power.

5. The Processor Module performs a restart without activating its application. The display on the front plate will show "PL" or "P3" (in case of system software is loaded).
6. Insert the diskette containing the AC 160 OPT*n* SW (*n* = number of option).
7. Use the Windows NT Explorer to browse to the file LOADER32.EXE and execute it.
8. The loader application starts. Click on <Next>.
9. Click on <User defined> to select COM port and speed manually or check the settings.
10. Click on <Next>.
11. The loader should automatically use the file AC160OP*n*.IMG (*n* = number of option). Select the serial interface that you have used in step 2.
12. Then click on <Download> to start the load process. Loading of the OPT software takes about 10 minutes.

2.4.3 Controller and I/O

2.4.3.1 Power-up

The minimum equipment necessary for power up is one Processor Module.

The station voltage should be switched on in stages. First, check the mains supply and then the station voltage supply.

1. Check that the circuit breakers on the power switch units are switched off.
   There is one circuit breaker for mains A (labelled S1) and one for mains C (labelled F1).
   Redundancy adds another circuit breaker for mains B (labelled S1).
   Reflect the relevance of:
   - Power switch in the cabinet housing the controller basic station
2. If SA610 power supply is used check that the on/off switch on the power supply module SA610 is in the "O" position.
3. Check that the **Mode** selector on the Processor Module in position "0" = STOP (see Section 2.4.3.2, Initialization).
4. Switch on the mains supply to the cabinet and check for correct mains voltage with a multimeter at the connection terminals on the power switch unit. See the terminal diagram form enclosed at delivery.
5. If SA610 power supply is used check that the LED (U_{in}) lights (indicating correct input voltage) on the SA610 power supply modules. Now switch on the power supply SA610 (on/off switch in the "I" position) and check that the LED (RUN) lights on the SA610 module.
6. Switch on the circuit breaker S1 on the power switch unit(s) in any order (mains A and B).
   Also switch on the miniature circuit breaker F1 for mains C.
   Several power switch and distribution units can exist in the controller basic station cabinet or in adjacent I/O cabinets.
7. Check for the following positive indications of a successful power-up (see Figure 2-5):

- Power Distribution Unit SX554 green LED LIVE (24 V)
- Processor Module green LED RUN
  display indication "P3" or "PL"
  (indicating working MODE, no application loaded:
  "P3" = MODE selector in STOP position
  "PL" = system software has to be loaded)
- Check that all the LEDs (FAULT and RUN) on communication modules and I/O modules are off.

8. There are also some negative indications, for example:
   - S600 I/O modules (red LED F (Fault))
     (Indicating that the modules are defect).
9. The target system is now ready for loading system software or download of application program by connecting the Engineering Station directly to connector **Com A** at the Processor Module.
10. Finally, set the MODE selector on the Processor Module in the COLD START position.

If correct indications fail to appear, trace the fault in accordance with the instructions given in Section 5.4, Fault Finding and User Repair.

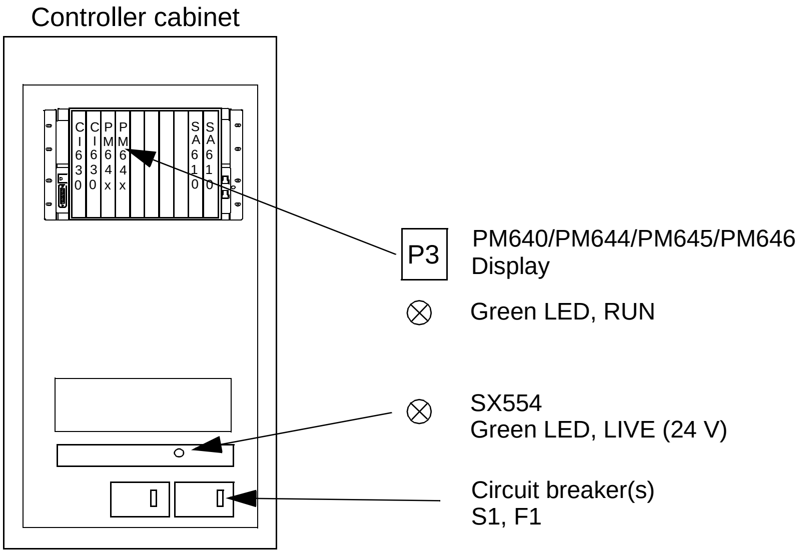


Figure 2-35. Power-up, Circuit Breakers and Positive Indications

For information about cabinet configuration please see Appendix C, Cabinet Configuration.

2.4.3.2 Initialization

In general, you can start an Advant Controller 160 in two different ways, as selected with the MODE selector on the Processor Module front. These ways and applications are described in more detail in Chapter 4, Runtime Operation.

If possible, a restart is made automatically by the Processor Module after an error is detected.

The normal position of the **Mode** selector is in COLD START position (Mode 1). At an interruption of the power supply, the system starts all application programs from scratch.

With the switch in the STOP position (Mode 0) the CPU does not restart any application program. Instead, it enters STOP MODE from where it must be restarted by the user.

The **Res** push-button initiates a CPU COLD START.

You can write control modules that are executed only after COLD START of the CPU. You can define how the process is to start with these control modules. Start-up features and their application are described in the manual *AMPL Configuration Advant Controller 100 Series Reference Manual*.

COLD START

Initialization starts from the beginning, and hardware and software are reset to an initial state. Application software is loaded from the internal PROM into the RAM.

The COLD START is the reaction to a power failure or if the RES button is pushed.

STOP

You can prevent the application program from starting if the **Mode** selector is in the STOP position.

An error, which restarts the CPU, leads to a system STOP independent from the position of the **Mode** selector.

After power-up, or after you push the **Res** button, the Processor Module is initialized, but the application software is not loaded from internal PROM. The system software continues to operate to allow access to stored error messages by means of Advant Station 100 Series Engineering Station (AS 100ES).

2.4.3.3 Connection of Engineering Station

If it is not installed during the setup phase (see Section 2.2.18, Engineering Station), you can plug the Engineering Station communication cable into the connector **Com A** on the Processor Module front at any time.

Work with the Engineering Station is supported by adequate documentation.
For detailed information about different configuration activities using Function Chart Builder, see the manual *AMPL Configuration Advant Controller 100 Series Reference Manual*.

If the actual Advant Controller 160 is a node in an Advant Fieldbus 100 network, you can connect the Engineering Station to any of the nodes included in the network. You can perform remote application programming and configuration in that way.

2.4.3.4 Configuration/Application Building

Configuration/application building is not part of the installation work described here. It is regarded as a separate activity and is treated in Chapter 3, Configuration of this manual as well as in separate documentation, for example, the manual *AMPL Configuration Advant Controller 100 Series Reference Manual.*

The configuration/application building results in an application program. Primarily, the application language AMPL is used during program design.

An application program for an Advant Controller 160 system consists of a DB part and a PC program. The DB part and PC program cannot be downloaded separately in order to retain data consistency.

The following must be fulfilled before you can load an application program from Advant Station 100 Series Engineering Station:

1. Start Application Builder (APB) and create an Advant Controller 160 node with the correct node address.
2. Start Function Chart Builder (FCB)
3. Create a DB part.
4. Create a PC program
5. Generate target code.
6. Connect the Engineering Station to Advant Controller 160.

You can now download the application program.

If an application program is already created, for example, in an identical system which is already tested, a program copy can be loaded. Note that target specific addresses must be considered!

2.4.3.5 Summary of the Controller Start-up and Verification of the Start

The following summary is a basic "from scratch" step-by-step instruction explaining how to start up. Other working schedules exist, especially in connection to revisions and system enlargement. Please refer to the reference manual *AMPL Configuration Advant Controller 100 Series Reference Manual* for complete information.

1. Power up.
   Set **Mode** selector to COLD START (Mode 1) on Processor Module.
   Set power switch on.
   For indications which verify a successful power-up, see Section 2.4.3.2, Initialization.
2. Processor Module indicates "P4".
   (P4 = no application program loaded)
3. Execute command Target/Connect of FCB at your Engineering Station
   (password input required).
4. Processor Module indicates "P6".
   (P6 = Function Chart Builder connected, on-line mode)
5. Download your application program.
   The modules are configured. The green LEDs of the configured modules are turned on.
6. Save your application program (in FPROM) of Processor Module.

7. Deblock your application program.
   The execution of your PC program starts.
   The system is now started and ready for operation.
8. Execute command Target/Disconnect of FCB at your Engineering Station.
9. Processor Module indicates “P1”.
   (P1 = Processor Module is in operational mode, application program running).

WARNING

When the application program is started, the process to be controlled is influenced.

Indications of an operating system with a started application:

- Analog inputs: A/D conversion in progress.
- Analog outputs: Output signals are produced by the executing PC program.
- Digital inputs: The LEDs on I/O module fronts show the process status regardless of whether or not the PC program is executing.
- Digital outputs: Output signals are produced by the executing PC program. Indicated by LEDs on I/O module fronts.

2.5 Product Verification

Since the test requirements vary considerably among different installations, the designer is responsible for determining the function requirements, the limits within which the function requirements are to apply and other parameters which apply in the installation.

Necessary Outfit

The following kit is a minimum requirement:

- Ordinary hand tools.
- Universal instrument, for example, digital multimeter.
- Test leads with 4 mm banana contacts and reducer contacts for a 2 mm test jack.
- Necessary parts of the documentation listed in Section 1.5, Related Documentation.
- Specific documentation enclosed at delivery, drawings, and so on.
- Advant Station 100 Series Engineering Station.

In more complex installations, which include closed loop control, some additional test equipment may be necessary/practical at tuning:

- Recorder with at least two channels.
- Access to an operator station facilitating object display trim curves and trend curves.

2.5.1 Safety Regulations

The instructions given in Section 2.2.1, Safety Regulations are applicable in all situations when you work with an Advant Controller and associated equipment. Please read the instructions carefully. One instruction is highlighted:

DANGER

Work with care when supply voltage is applied to the system. The voltage in the cabinet can cause injury and can even kill a human being.

2.5.2 Servicing Tool

Installation of an Engineering Station, the main servicing tool, is described in Section 2.4.3.3, Connection of Engineering Station. Detailed information for its use is given in separate documentation.

2.5.3 Commissioning

2.5.3.1 General

For a general description of how to set the controller in operation and start the execution of an application program, see Section 2.4.3.5, Summary of the Controller Start-up and Verification of the Start.
Below you can find general information on some function tests which you can perform to verify the product. Short notes on adequate facilities provided by the Engineering Station are also listed.
For a more detailed description, see *AMPL Configuration Advant Controller 100 Series Reference Manual*.

2.5.3.2 Procedure

The application program is normally checked, one executing unit at a time. This is done by deblocking the complete PC program and successively deblocking the executable units, one after the other. You can, for example, check the flow valve functions and then verify the start sequence for a pump motor, and so on.

After each sub-function is tested, a comprehensive function control is performed to verify that all executable units function together.

Finally, a full scale check of the complete installation is performed to verify that the program is in accordance with the plant specification.

2.5.3.3 Blocking and Deblocking of the PC Program

During a test of the application program, you can prevent the control system from affecting the process in two ways:

- By withdrawing the process connectors at the S600 I/O modules (or likely locations) to physically isolate output signals from the process.

- By blocking the PC program execution with the help of certain commands of Advant Station 100 Series Engineering Station.

Commands of Advant Station 100 Series Engineering Station for blocking the PC program execution:

- Target/Block
  Blocking of the PC program execution. Outputs of I/O modules keep their actual values.
- Target/Deblock
  Deblocking of the PC program execution. Outputs of I/O modules will be updated according to PC program execution.

NOTE

In case of safety applications using the PC element PC_DX610, the outputs of the relay module DX610 don't remain as before but will be forced to zero after blocking of the PC program execution. Additionally the relay on the Processor Module will be de-energized and can be used to switch off the output modules.

2.5.3.4 Test Facilities Provided by Engineering Station

For a detailed list and detailed descriptions, see the manual *AMPL Configuration Advant Controller 100 Series Reference Manual*.

On-line Modification of Application Program

On-line configuration and programming is the modification of a user application program on an Engineering Station connected to an Advant Controller 160 system. Modification in this case includes insertion and deletion of executable units or PC elements, and insertion of DB elements.

On-line configuration and programming is only possible with Function Chart Builder running in *on-line* mode.

Function Chart Builder can only be in on-line mode when it is connected to the Advant Controller 160 target and when the same version of the application program is selected on both the Engineering Station and the Advant Controller 160 target.

CAUTION

> Process equipment may be damaged!
>
> The consequences of on-line modifications must be fully considered and understood before taking actions.

Using Function Chart Builder in on-line mode has some special effects to be considered:

- Modifications in the PC editor (tree representation or function chart representation) can be made within only one executable unit at a time. Before proceeding within another executable unit, perform the **Target | Load Application** command.
- Modification of the scheduling strategy of a control module (cyclic activation, activation at initialization, and so on) is not allowed.
- Modifications in the DB editor are not allowed if modifications have been made in the PC part without performing the **Target | Load Application** command.
- After leaving an editor with the **Target | Load Application** command, the modified executable unit or the modified DB element is converted to target code, downloaded to the Advant Controller 160 target and switched to execution automatically.
- During on-line programming applications with sequences, if you insert a new STEP element or delete an old STEP element, the sequence is first executed once in RESET-mode after on-line change. RESET-mode of the sequence means that all outputs of the STEP elements are set to its default values which normally are 0.

For detailed description of windows, commands and dialogs see the *AdvaBuild for Windows Function Chart Builder User's Guide*.

Test Functions for PC Part

The test functions perform value displaying (monitoring) and value forcing.

These test functions are available in Function Chart Builder running on the Engineering Station in on-line mode only.

The Engineering Station is in on-line mode when it is connected to the Advant Controller 160 target with the same version of the application program selected on both the Engineering Station and the target.

Test Functions for PC Part, Display and Forcing

Value display (monitoring) and forcing of PC terminals are parts of the test functions of the Engineering Station.

Function Chart Builder presents the monitored and forced values in

- function chart representation giving information about the values within a section of the application shown on the screen
- table representation collecting the variables distributed over the application.

When forcing PC terminals you should be aware of following.

CAUTION

Process equipment may be damaged!

The consequences of forcing values must be fully considered and understood before taking actions.

Be aware that forced values—for the PC part—on the target system are valid only during in the test function of the Engineering Station. When you leave the test functions on the Engineering Station, all the force values on the target will be cleared.

The force values are downloaded to the target system and become active in the target system at the next execution of the related executable unit.

Forcing PC terminals is a temporary function. When you leave the test functions on the Engineering Station, all the force values on the target will be cleared.

The Function Chart Builder stores the marking of terminals to be forced and their values on the Engineering Station and they are available at the beginning of the next session.

NOTE

The values displayed on the Engineering Station are determined at the **end of the execution** of the related executable unit. In the following example, the display shows the value of the variable after being overwritten by a force value. The input terminal of the PC element MOVE at execution times is supported by the calculated output terminal of the AND element.

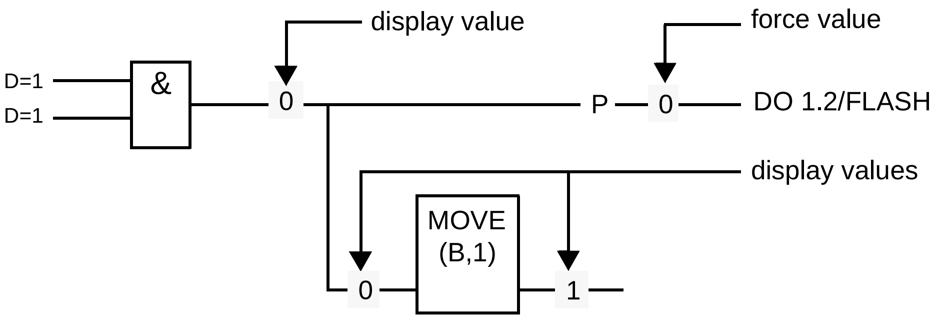


Figure 2-36. Example of Display and Force Values

Test Functions for DB Part, Display and Forcing

Value display (monitoring) and forcing of DB terminals are parts of the test functions of the Engineering Station. DB terminal forcing is only supported by the extended DB elements, see *Data Base Elements Advant Controller 160 Reference Manual.*

Function Chart Builder presents the monitored and forced values in a table representation collecting the variables distributed over the application. When forcing DB terminals you should be aware of following:

CAUTION

Process equipment may be damaged!

The consequences of forcing values must be fully considered and understood before taking actions.

Be aware that force values—for the DB part—on the target are valid also when the Engineering Station is disconnected. The forced values must be cleared by the engineer via the Engineering Station if they shall not be valid any longer.

The force values downloaded to the target system become active on the target system at the next execution of the related executable units.

Forcing DB terminals is a permanent function. When you leave the test functions on the Engineering Station, all the force values on the target are still active.

2.5.3.5 On-line and Off-line Program Changes for Dual Redundant Processor Modules

Tracking

There are two types of tracking applicable:

- Unplanned tracking applicable for CPU redundancy only
- Planned tracking applicable for CPU and station redundancy.

Dependent on the used tracking types there are some differences concerning program changes as described below.

On-line Change

Specific limited changes of the application program can be done on-line. On-line means that the application program runs without interruption while the changes are performed and made effective. On-line changes of the PC part are limited to only one executable unit at a time.

On-line changes can be made only on the master in case of CPU redundancy, otherwise on master and slave. The data transfer via HSL—also for the planned tracking—is stopped due to the on-line change. The redundancy is dissolved, that is switchover to the slave is prevented.

With planned tracking for recovery of the redundancy the modification must be done for the master and for the slave. Dependent on the implemented changes it may be necessary to modify the planned tracking too.

In case of unplanned tracking the changed program can be copied from the master to the slave via an operator command at the Engineering Station. With planned tracking the program change for master and slave can be done on-line one after another. In any case the function of the application program is persistently available at any time.

Off-line Change

Off-line changes can be done for all kind of program including creation of a totally new application program. Off-line means that the application program is changed in the tool without on-line connection to the CPU. After compilation in the tool the complete application program can be downloaded.

The operation of both redundant CPUs must be stopped at the same time prior to downloading in case of unplanned tracking. The application program needs to be downloaded to both CPUs. There is no automatic copying between master and slave. During this time no CPU performs the control tasks. After the download the CPUs can be started. One CPU becomes master, the other one becomes slave.

With planned tracking implemented the new application program can be downloaded to the slave and can be tested with the slave without impact on the process. Meanwhile the master controls the process with the old application program. Automatic switchover to the slave is prevented during this phase. If the new program on the slave was tested successfully, a switchover to the slave can be done in order to test the new application program also together with the process. Switchover from master to slave can be done through reset of the master CPU via the RES push-button or through master select and switchover with use of the redundancy test module 89RT01. The last method should be applied by preference. If this test was successful too the new program can also be downloaded to the former master, the actual slave. After that both CPUs contain the new application program and the redundancy can be established again.

WARNING

> Be sure that the actual slave Processor Module is ready to take over (code “b1” on 7 segment display) before you reset the master. Otherwise the respective application fails.

Dependent on the changes done it can be necessary to modify the planned tracking too.

Update Redundancy Slave

After the master is changed the slave CPU has to be updated. There are two methods to do this:

- via an operator command at the Engineering Station connected to the master
- via the **Ack** push button at the slave module

The following summary is a step-by-step instruction explaining how to update via **Ack** push button:

1. At first the master module has to run in "P1"
2. Set **Mode** selector to STOP position (Mode 0) on slave module.
3. The slave module indicates "P3".
4. Set **Mode** selector to COLD START (Mode 1) on slave module.
5. Push the **Ack** button.
6. For a period of 1–2 minutes the slave will be update from the master. The new application program will be saved in PROM. During this time the slave module indicates "P4".
7. The update procedure is finished when the startup of the application program will be executed. The slave module indicates "P5".
8. The slave module is operational again when the display indicates "b1".

Manual Switch-over of Redundant PM645/PM646

NOTE

This procedure is only valid for Advant Controller since release 1.0/3.

Before you perform a manual switch-over of redundant PM645 or PM646, check if the slave Processor Module is ready to take over. This can be done with AS 100ES (Status Report) or by reading the segment display on the front side of the slave Processor Module. If the display shows "b1" the slave is ready to take over.

The following alternative procedures can be applied to switch redundancy:

1. Reset the master Processor Module with the **Res** push button. If the master PM should be removed after switch over please switch the Start mode selector in position 0 before resetting the CPU.
2. Switch over with use of the redundancy test module 89TR01.
3. Forced switch over through simulation of the terminal SWITCH=1 of the PM645 or PM646 Data Base element.

WARNING

Do not remove the CPU redundancy cable if both Processor Modules are running—master and slave in standby—otherwise both Processor Modules become master, which results in a process failure.

2.5.3.6 On-line and Off-line Program Changes for Triple Redundant Processor Modules

The description for dual redundant Processor Modules is valid with the following exceptions.

On-line Change

During on-line change only the data transfer from and to the affected Processor Module is stopped. Therefore the redundancy falls back from 2 out of 3 to 1 out of 2.

For 2 out of 3 station redundancy on-line changes must not be done for the master. First the on-line changes must to be done on both slaves. After that redundancy must be switched over and the on-line change must now be done on the previous slave.

WARNING

> In case of 2 out of 3 station redundancy on-line changes must not be done for the master. Otherwise in case of fast process transients it could happen that the slaves declare the master defective because they compare its output values with the frozen one of the master.

Off-line Change

During off-line change the remaining two Processor Modules form a 1 out of 2 redundancy.

2.5.3.7 Tuning of Feedback Control Loops

When feedback control functions are used in the Advant Controller system, select the optimum sampling time for the process concerned and set other feedback control parameters so that the feedback control becomes stable under varying loading conditions, and so on.

2.5.3.8 Check of Process Input/Output System

General

The process connectors are now inserted and the channels are tested one by one. The output channels are tested from the PC program to the actuators in the process, and the input channels are tested from the transducers to the application software. In both cases, the operation of the hardware functions is observed on the signals on the modules and the operation of the software functions is observed on the screen of AS 100ES.

It may be necessary to simulate digital and analog input signals which are normally generated by the process. Suitable methods to do this are:

- Digital inputs

  Activate the input by applying a voltage, corresponding to the rated input signal voltage, as close as possible to the process transducer, in order to test as much of the process wiring as possible. You can also generate a test input signal by operating transducers manually, for example, by actuating limit switches.

- Analog inputs

Use a signal generator to generate analog signals. A simple test circuit to generate a voltage consists of a potentiometer connected across a suitable voltage source capable of producing a positive and a negative output. You need a current source capable of at least 20 mA to generate current signals. Analog test signals should also be injected as close as possible to the signal transducer to test as much as possible of the process wiring.

You can show on-line updating of input signal values on Advant Station 100 Series Engineering Station in the “Test” menu.

For a detailed description of how to operate the “Test” menu, see the Advant Controller 160 manuals *AMPL Configuration Advant Controller 100 Series Reference Manual* and *Advant Station 100 Series Engineering Station Function Chart Editor.*

The following must be fulfilled before you can set I/O parameters or display them on Advant Station 100 Series Engineering Station:

1. Create an “Advant Controller 160” node in Application Builder (APB) on the Engineering Station.
2. Create the DB part, that is, the necessary DB elements for I/O modules and channels (DI, DO, AI, and so on) in Function Chart Builder.
3. Create a PC program in Function Chart Builder.
4. Generate target code for the application program.
5. Connect the Engineering Station to Advant Controller 160 and download the application program.
6. Start the application program on Advant Controller 160.

Testing Input Signals

Test a digital input channel as shown in Figure 2-37. The procedure is very similar for analog signals (refer to Figure 2-38). Test digital and analog input channels as follows:

- Select a PC element terminal connected to the related DB element in the Advant Station 100 Series Engineering Station function “Test”.
- Select the menu item for display on Advant Station 100 Series Engineering Station.
- Activate the signal input by activating the signal transducer or by simulating the signal.
- Check that the corresponding yellow LED on the input module lights up (only digital modules). For analog inputs, measure the signal with a multimeter at the terminal of the process connector of the corresponding channel. Check that the change appears at the terminal “VALUE” of the DB element on the Advant Station 100 Series Engineering Station screen.
- Switch the test signal for a digital input to logical “0” and check that the yellow LED on the input module extinguishes and that the signal at the “VALUE” terminal goes to “0”.
- Note that yellows LEDs for DI685 modules are lit in case the wire break option is chosen and no wire break is detected.

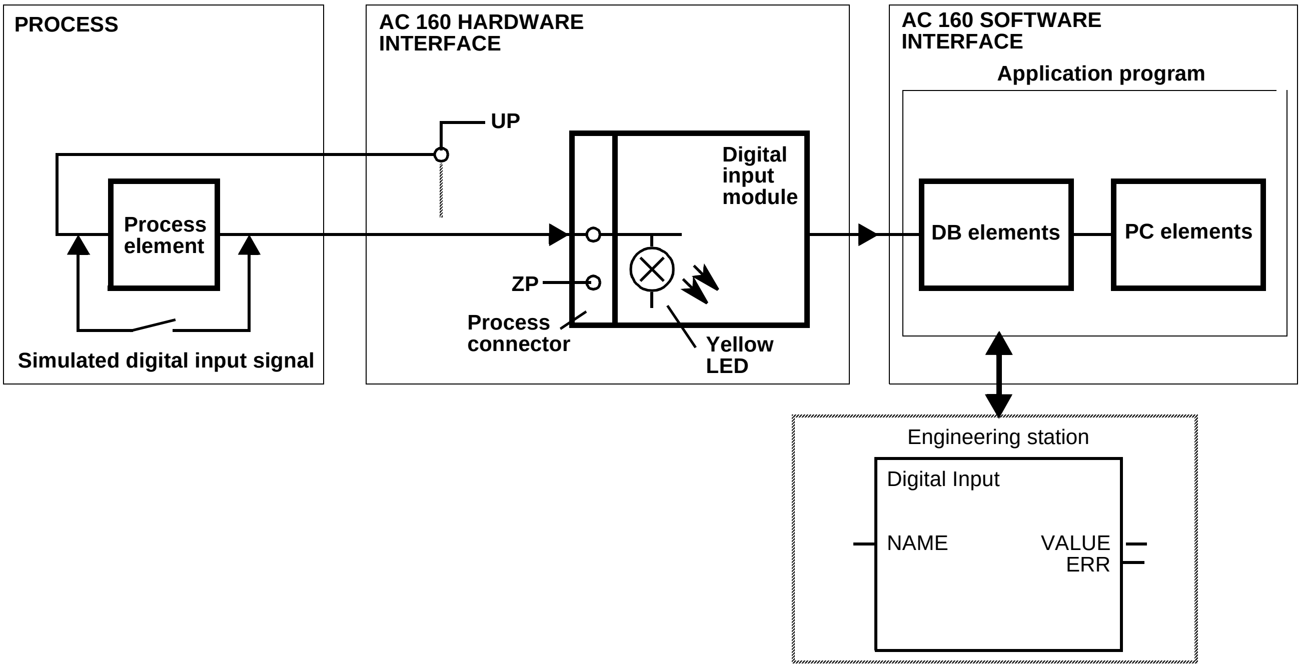


Figure 2-37. Testing Digital Input Signals

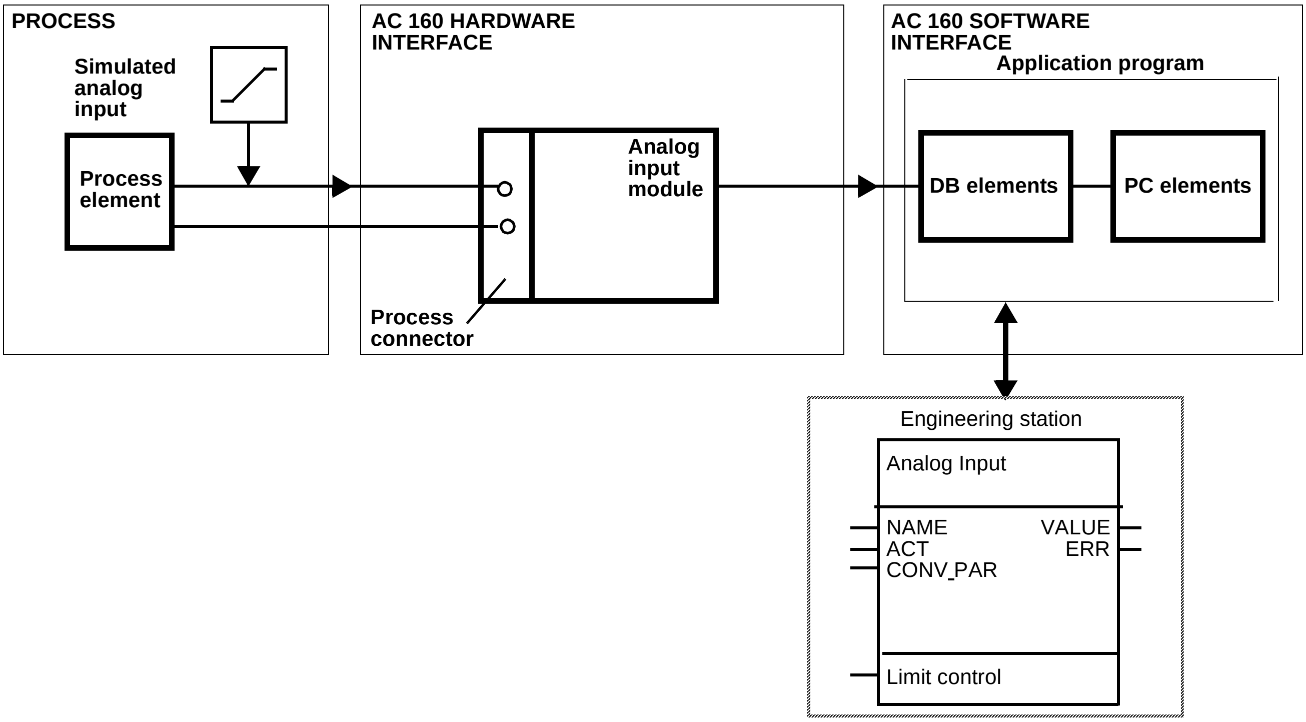


Figure 2-38. Testing Analog Input Signals

Testing Output Signals

Test a digital output channel as shown in Figure 2-39. The procedure is very similar for analog signals (refer to Figure 2-40). Test digital and analog output channels as follows:

- Select a PC element terminal connected to the related DB element in the Advant Station 100 Series Engineering Station function "Test".
- Select the menu item for forcing output signal values.
- Select the "VALUE" terminal on the DB element and enter the desired output value.
- Check that the corresponding yellow LED on the output module lights up (only digital modules). For analog outputs, measure the signal with a multimeter at the terminal of the process connector or at the actuator.
- Reset the desired output value to a low value and check that the yellow LED on the module extinguishes and that the signal value changes.

NOTE

The yellow LEDs on the module DO610, which indicate the status, light only if the process voltage "UP" (that is, 24 V d.c.) is connected.

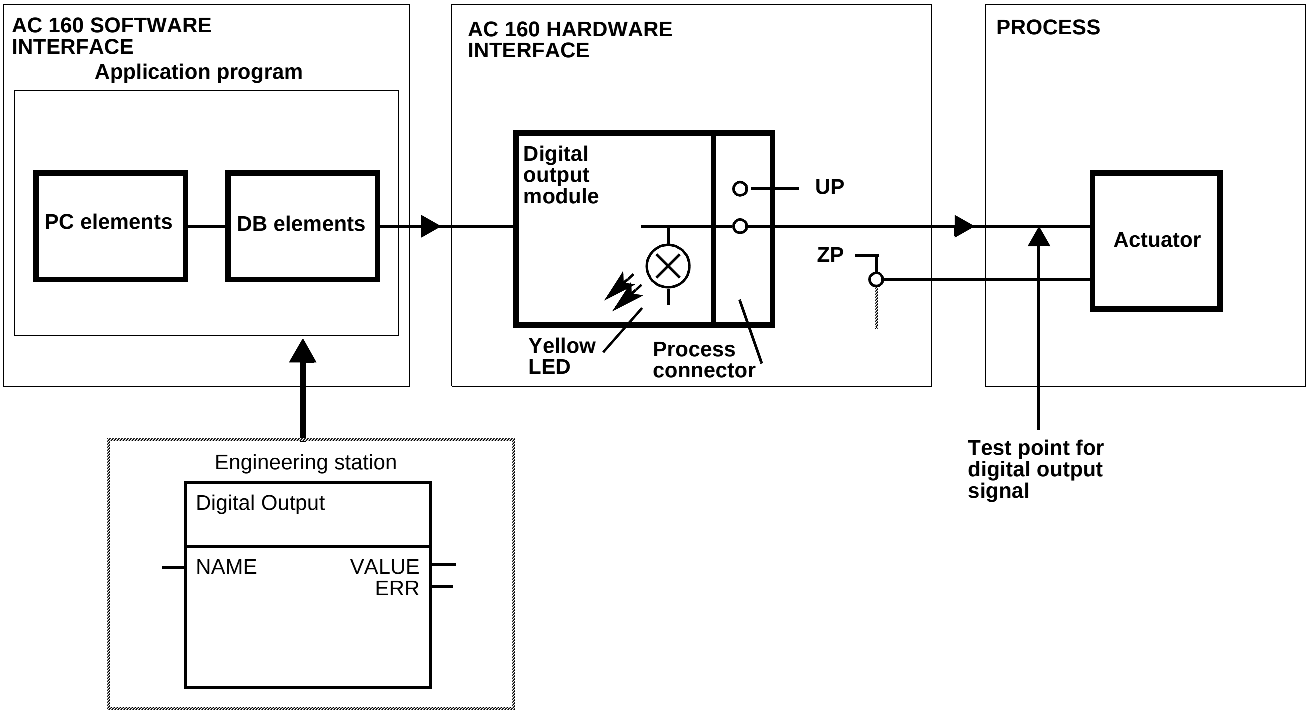


Figure 2-39. Testing Digital Output Signals

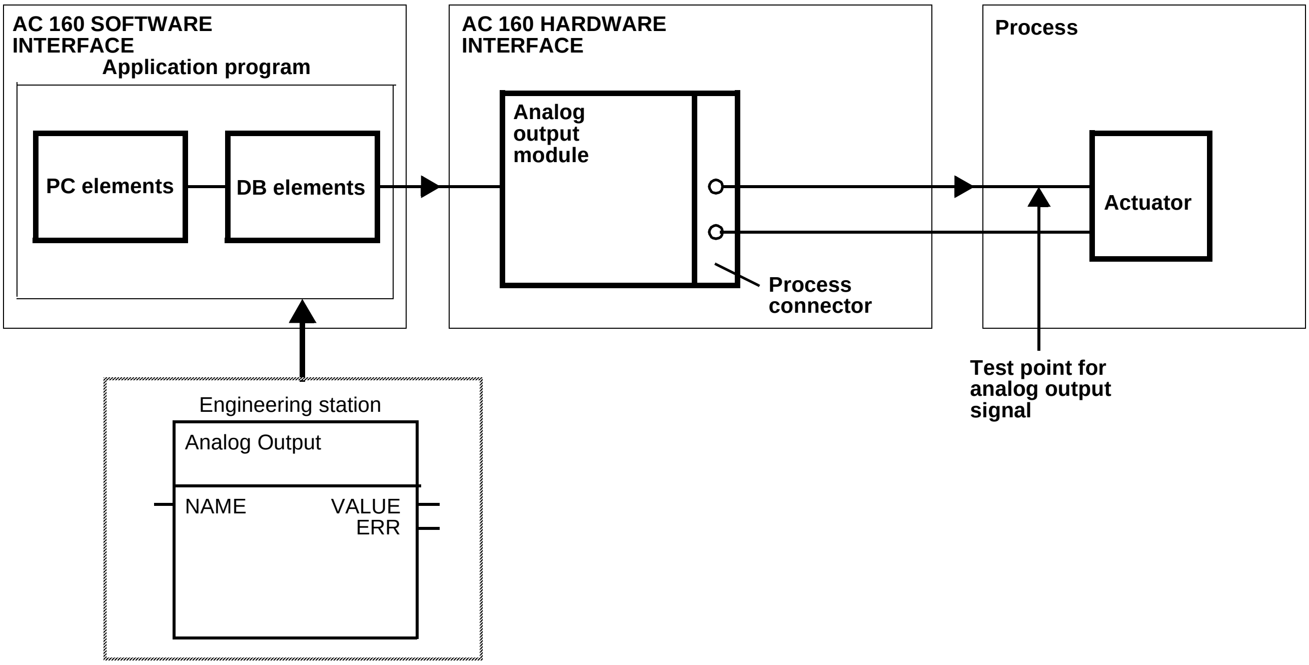


Figure 2-40. Testing Analog Output Signals

2.5.4 Final Control

When the control system testing is complete and the plant is functioning satisfactorily, take the following actions:

- Check that all modules are properly inserted in the subrack and that no screws are loose.
- Check that all terminal screws on process connectors and terminal units are properly tightened and that all grounding is effective.
- Check that all cable bushings are installed properly to avoid cable wear.
- Check that no tools or debris from cable installation remain in the cabinet. Clean the cabinet.
- Make a final listing of the DB and PC parts of the application program to obtain correct documentation of the system, including all tuning parameters.
- Generate source code of your final DB and PC program part and save it with Advant Station 100 Series Engineering Station, see the manual *AMPL Configuration Advant Controller 100 Series Reference Manual*. You can generate your actual target code from this source code if it is necessary.

2.6 Implementation of Functions in Systems Already Operating

Enlargement of the system with additional functions differs from a "from-scratch installation". The main reason they differ is that the system is or has been in operation, which means that on-line/off-line aspects are important. The influence on the application program is also important. From these viewpoints, among other things, the most common additional functions are treated below.

Necessary Outfit

The following kit is normally a minimum requirement:

- Ordinary hand tools.
- Universal instrument, for example, digital multimeter.
- Test leads with 4 mm banana contacts and reducer contacts for a 2 mm test jack.
- Necessary parts of the documentation listed in Section 1.5, Related Documentation.
- Specific documentation enclosed at delivery, drawings, and so on.
- Advant Station 100 Series Engineering Station.

In more complex installations, which include closed loop control, some additional test equipment may be necessary/practical at tuning:

- Recorder with at least two channels.
- Access to an operator station facilitating object display trim curves and trend curves.

2.6.1 Servicing Tool

See Section 2.4.3.3, Connection of Engineering Station for a description of installing an Engineering Station, the main servicing tool. For detailed information about its use, see separate documentation.

2.6.2 Safety Regulations

The instructions given in Section 2.2.1, Safety Regulations are applicable in all situations when you work with an Advant Controller and associated equipment. Please read the instructions carefully. One instruction is highlighted:

DANGER

Work with care when supply voltage is applied in the system. The voltage in the cabinet can cause injury and can even kill a human being.

2.6.3 General Guidelines

Naturally, all design considerations given in Section 3.1, Considerations apply. These considerations are also relevant to installation in a system already in operation. Among other things, you may want to reflect upon:

- Hardware, types and location.
- Restrictions in combinations of functions.
- Software options needed to produce the additional application you desire, for example, software option OPT1 for additional PC elements.
- Interface to application program to be used.
- CPU load.
- Memory consumption.
- Power supply requirement.
- Heat dissipation.

In Table 2-13, you can find information about whether or not a function can be implemented on-line.

On-Line/Off-Line

On-line means that all work can be carried out while the controller is in full operation. Because of the risk of making manual mistakes in such handling, and the possible severe consequences to the process controlled, it is recommended that you use this on-line facility restrictively.

Source Code of Application Program

Before installing a new additional functions or new system software, generate source code of your application program (DB part and PC part).

The source code enables you to generate the "origin" target code of your application program if you want to cancel the changes you made. However you need only the source code in one case, when the compatibility of the target code is not guaranteed. This normally happens with new releases and not with revisions.

Summary of Aspects

Table 2-13. Implementation of Functions in Systems Already Operating

Function/Equipment	Enlargement/Addition	
	On-line	Off-line
System software		X
I/O module (S600 I/O)	X	
I/O extension subrack (S600 I/O)		X
Bus extension to S600 I/O station	X	
Advant Fieldbus 100 (CI modules (1), DSPs)	X	
PROFIBUS-DP	X	
RCOM	X	
Siemens 3964R	X	
MODBUS	X	

(1) Only with redundant bus lines. One bus line must always be operational.

2.6.4 Additional I/O Modules

Replacement of faulty modules is described in Chapter 5, Maintenance.

For a detailed description of the connection and use of an Engineering Station and different commands, see separate documentation, for example, *AMPL Configuration Advant Controller 100 Series Reference Manual*.

Preparation and Setup

I/O modules are normally grouped by type, so place the new module with modules of the same type, if possible. Note, however, that you must consider the power requirement and heat dissipation.

Route cables in accordance with the guidelines set forth in Section 2.2.8, Cable Routing in Cabinets.

Mount I/O functions in the following way:

1. Make a plan for the work to be done.
   - Read the General Guidelines above and apply the information.
   - Check for available spare position(s) in the subrack(s).
2. Make a source code of your application program (if not already available).
3. Switch off the supply voltage to the control system (recommendation, not mandatory).

NOTE

Remember that the control function of the system ceases and the process being controlled is affected.

4. Install the S600 I/O process connector with the wiring between process connector and the terminal unit/terminal blocks to which the process cables are connected.
5. Ensure that there is no tension in the wiring.
6. Insert the new module. Ensure that it is fully in place up to the hinge of the subrack. Tighten the module-securing screw.
7. Insert the process connector and tighten the connector screw.
8. Connect the process cables to the terminal unit/terminal blocks. Reflect upon all installation rules regarding cable routing and grounding.
   As an alternative, first make a functional verification when the process is not connected. Then connect.

Start-up

The start-up is carried out in different ways, depending on the main working mode, on-line or off-line.
If a module is **added on-line**, the additional I/O modules are put into operation as the adequate DB elements are created and the changed DB part of the application program is downloaded. The additional modules are taken into operation automatically and their green LEDs are switched on.

You can, of course, switch off the power supply during the installation work.
Then switch on the power supply, keeping the MODE selector on the Processor Module in the COLD START position. The system is restarted and in full operation except for the additional module. The additional I/O modules are put into operation as the adequate DB elements are created and the changed DB part of the application program is downloaded.

If the module is **added off-line,** change your application program off-line, download and deblock it. The additional I/O modules are put into operation as the adequate DB elements are created.

Perform the final steps, which include start of application programs, successively, especially those application programs which are affected by the additional I/O modules.

WARNING

When the application program is started, the process to be controlled is influenced.

Verification

Make functional tests, including process functions, as applicable.

If correct indications fail to appear, trace the fault in accordance with instructions in Section 5.4, Fault Finding and User Repair.

2.6.5 Loading or Upgrading Additional System Software Options

For a detailed description of the connection and use of an Engineering Station and different load commands, see separate documentation, for example, *AMPL Configuration Advant Controller 100 Series Reference Manual*.

NOTE

Loading or upgrading an option leads to a restart of Advant Controller 160.

Follow this procedure to load or upgrade an Advant Controller 160 system software option:

1. Put the Processor Module **Mode** switch into STOP position.
2. Press the **Res** button of the Processor Module.
3. Wait until the Processor Module display shows “P3”.
4. Connect the Engineering Station to Advant Controller 160.
5. Start the Engineering Station.
6. Put the floppy disk containing the option and the loader into the Engineering Station's drive A.
7. Start the File Manager of Windows (or Windows for Workgroups) by double-clicking on its icon in the Main group.
   Select the drive A by clicking on its icon in the drive bar.
8. Find the SETUP.PIF file in the directory window of the File Manager. Start loading or upgrading the new option by double-clicking on the icon of the SETUP.PIF file.
9. When you have successfully loaded or upgraded the option, it is indicated on the Engineering Station's screen.

CAUTION

If the option loading or upgrading process is interrupted by either pressing the RES button or a power failure, the system software and any previously loaded or upgraded options are erased and must be loaded again.
This state of the Processor Module is indicated on its display by showing “PL”.

Chapter 3 Configuration

3.1 Considerations

This section tells you some of the things you need to think about during configuration and application building. This follows the primary structure outlined in Section 1.8, Product Overview, however, some subsections have been added. The information is given as concisely as possible under the following headings, as relevant.

- **Appropriate Hardware and Software**

  What is necessary to achieve a function
- **Interface to Application Program**
- **Guidelines**

  Typical information:
  - Location of hardware
  - Recommendations
  - Limitations.

For information on the possible number of instances, please see Section 3.2, Capacity and Performance.

3.1.1 Product Structure

The product structure deals primarily with general functional modularization. In that context, questions regarding number of supported functions, possible combinations of functions, and so on, are relevant. For the answers to such questions, see Section 3.2, Capacity and Performance.

Regarding the realization of functions, please note that the hardware structure and the software structure of the product differ. A functional option may require extra hardware, but the software is included in the Advant Controller 160 BASE software. Or an Advant Controller software option may support several functional options (each with dedicated hardware).

The following diagrams shows you the structure of the components of an Advant Controller 160 system on different levels.

3.1.1.1 System Structure

Advant Controller 160 can communicate with other components of the Advant OCS system. Figure 3-2 shows the buses and links for connection.

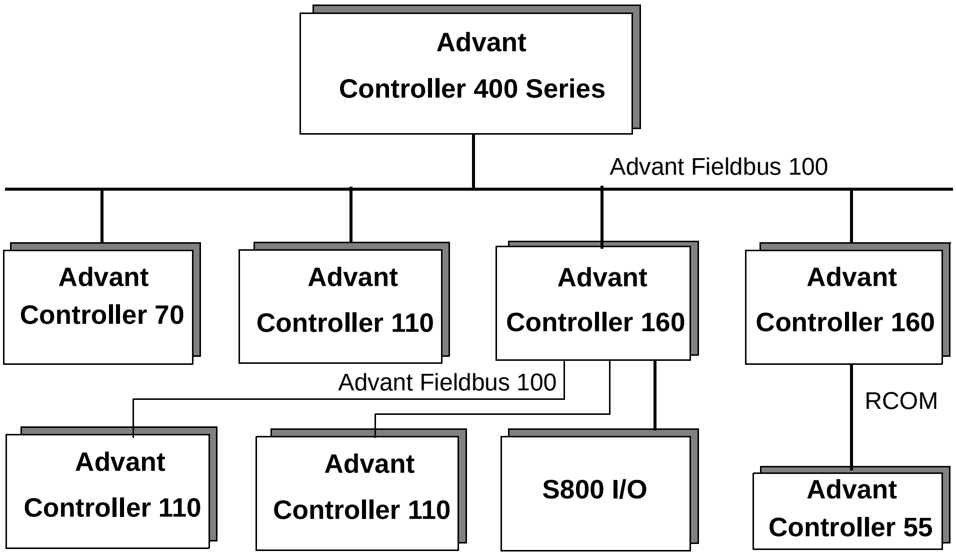


Figure 3-1. Example of Advant OCS System Structure with Advant Controller 160

3.1.1.2 Block Diagram

Figure 3-2 indicates broadly the functional relationship between main system utilities and how the hardware is structured. This is an example of Advant Controller 160 with the Processor Module PM640.

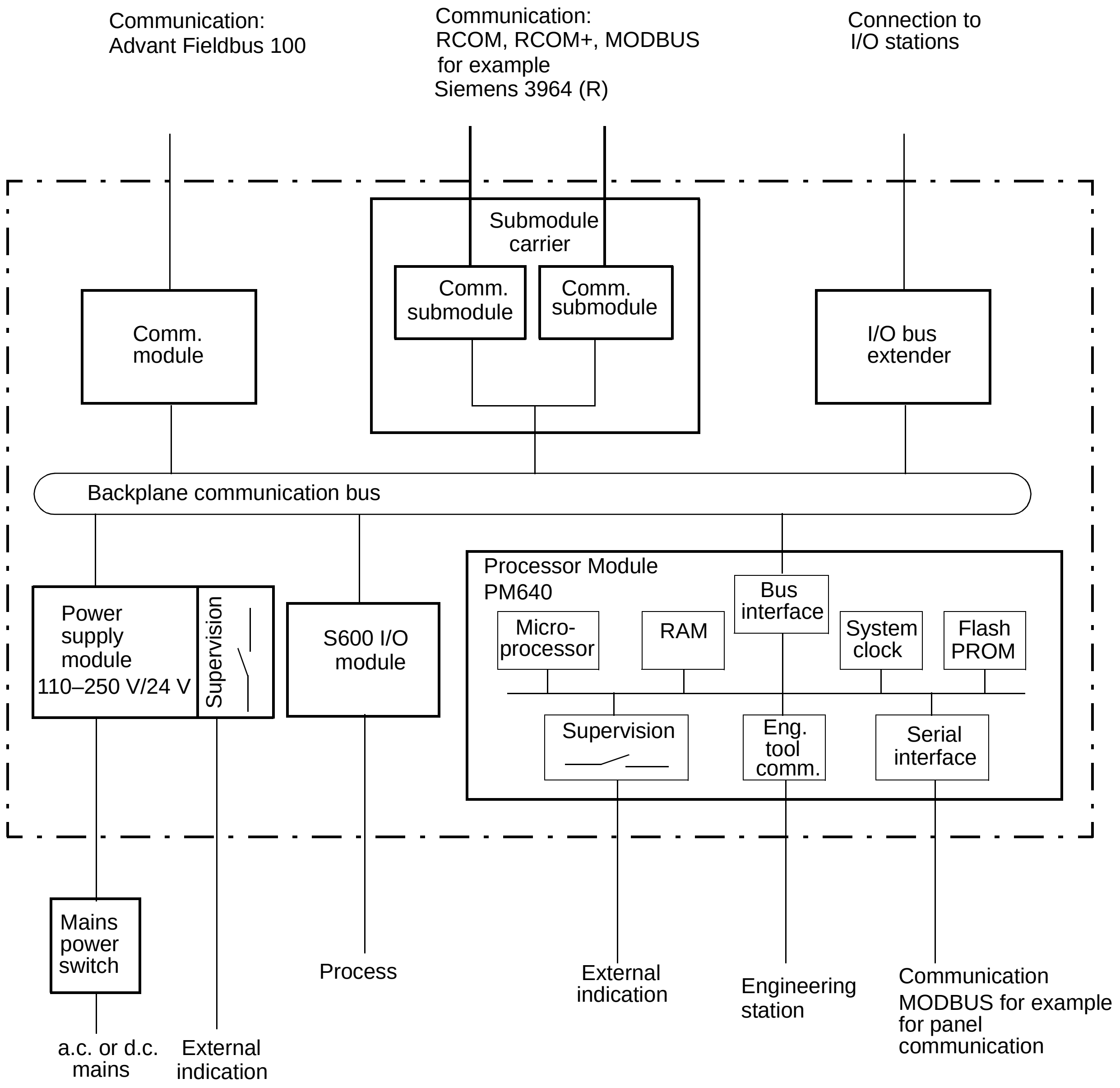


Figure 3-2. Block Diagram of Advant Controller 160 with Processor Module PM640

Figure 3-3 indicates broadly the functional relationship between main system utilities and how the hardware is structured. This is an example of Advant Controller 160 with the Processor Module PM644.

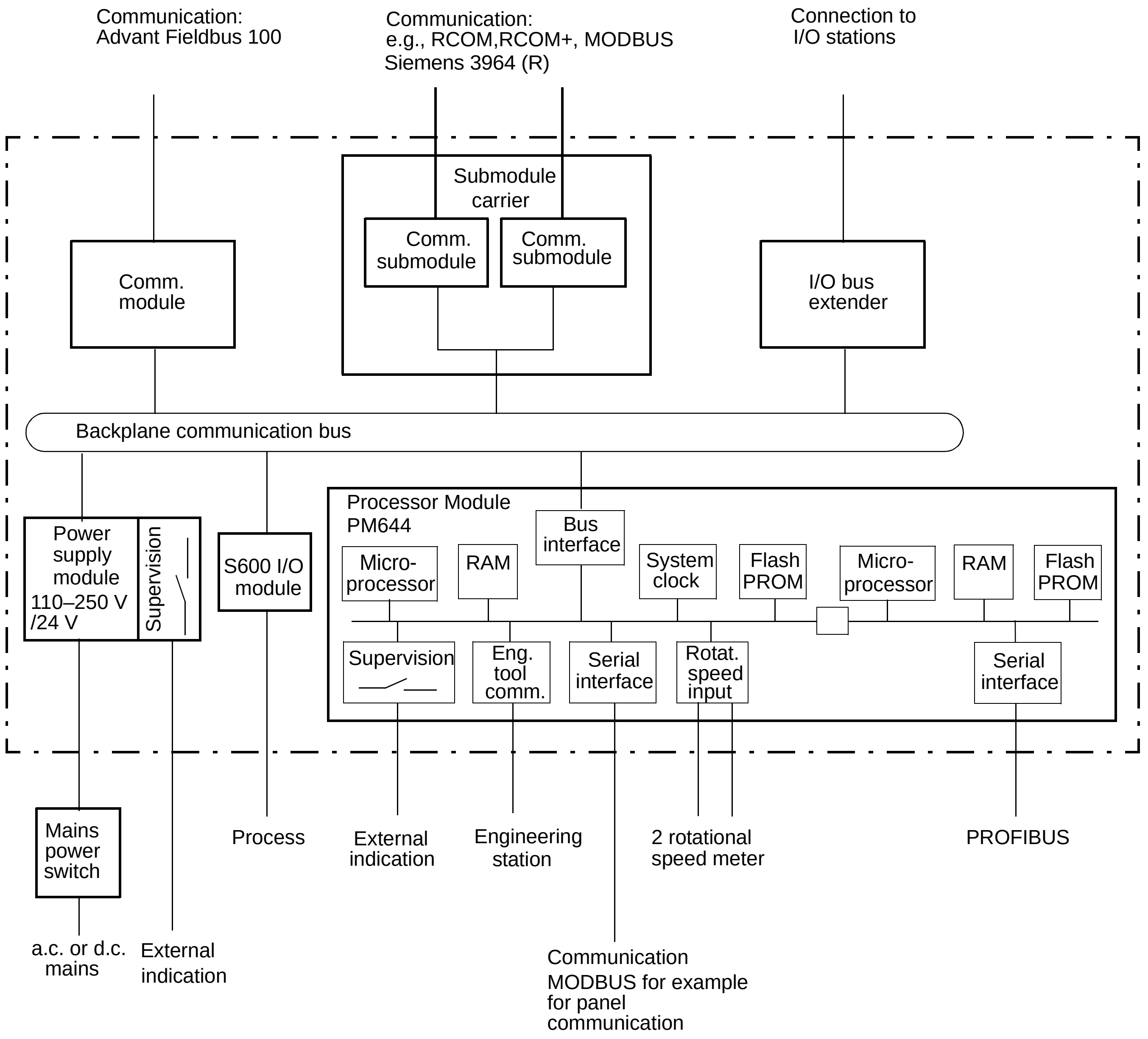


Figure 3-3. Block Diagram of Advant Controller 160 with Processor Module PM644

Figure 3-4 indicates broadly the functional relationship between main system utilities and how the hardware is structured. This is an example of Advant Controller 160 with the Processor Module PM645.

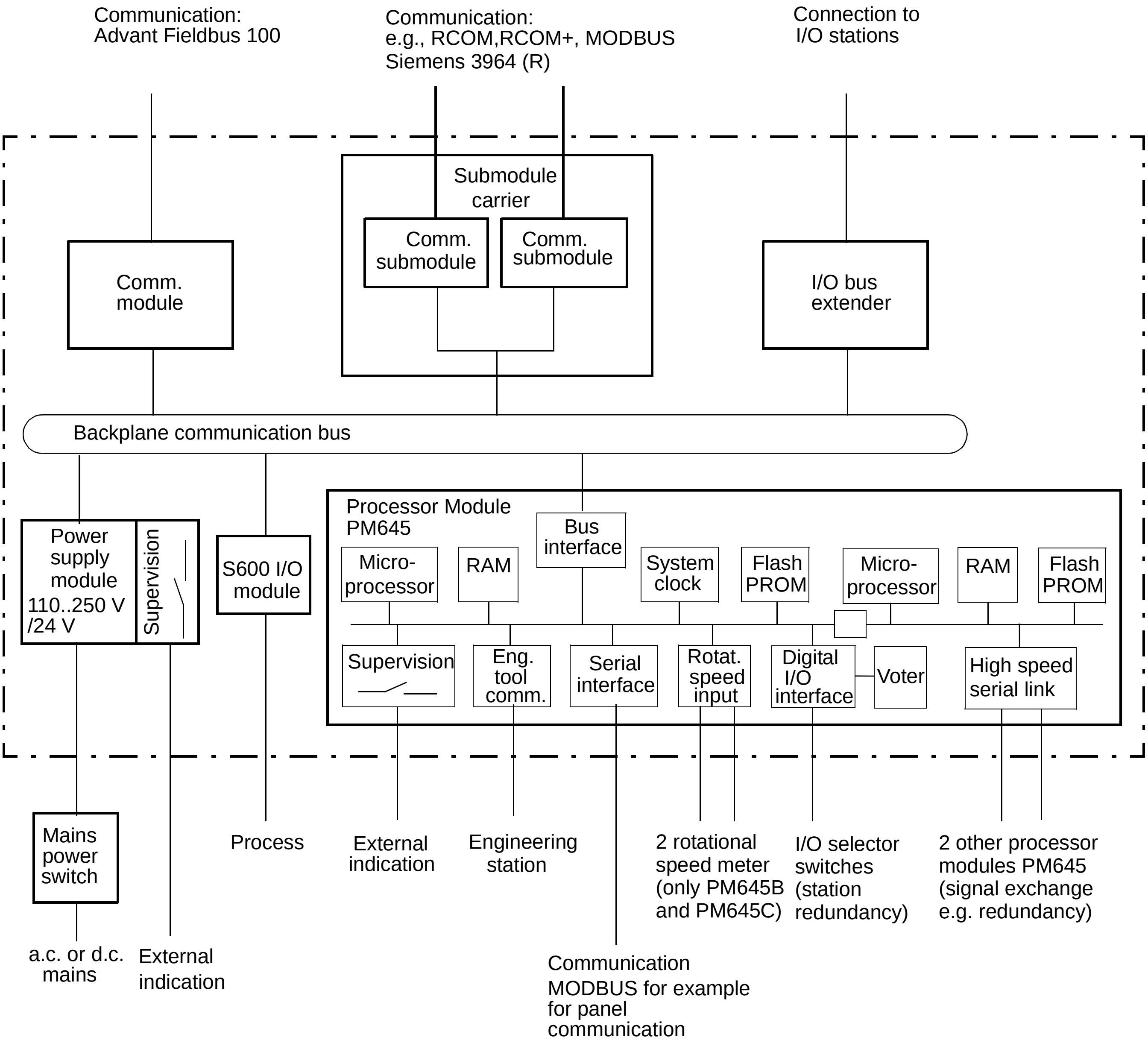


Figure 3-4. Block Diagram of Advant Controller 160 with Processor Module PM645

Figure 3-5 indicates broadly the functional relationship between main system utilities and how the hardware is structured. This is an example of Advant Controller 160 with the Processor Module PM646.

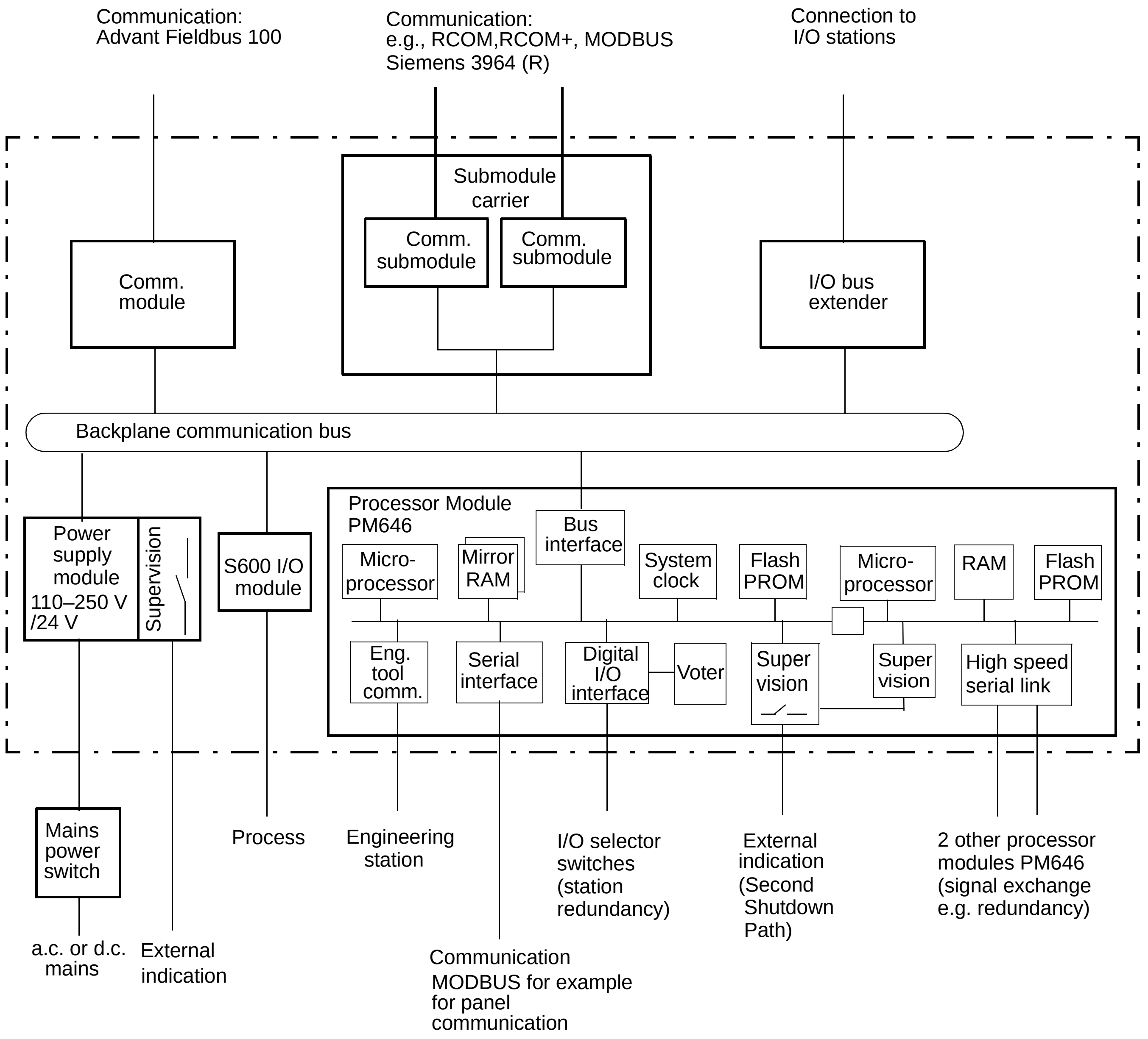
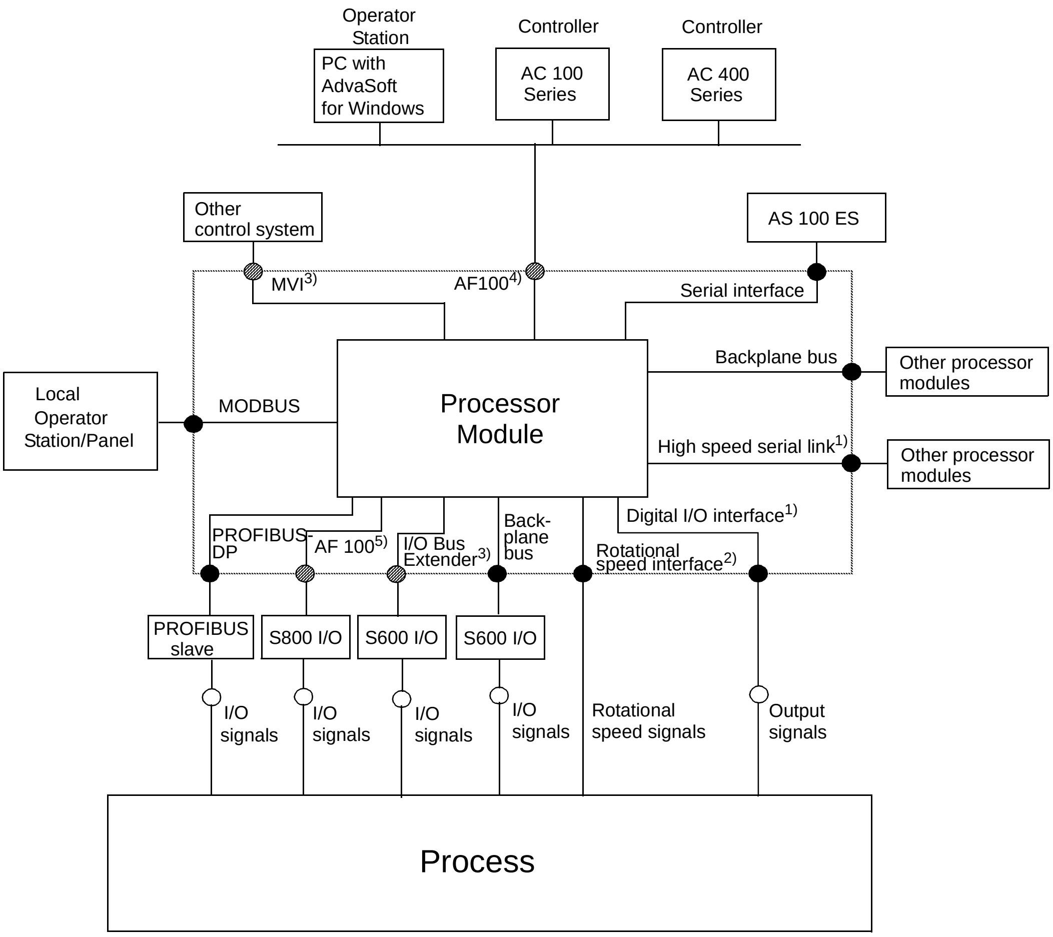


Figure 3-5. Block Diagram of Advant Controller 160 with Processor Module PM646

3.1.1.3 Functional Interfaces

Besides the more “internal” communication, a controller also communicates with a wide range of peripherals. Figure 3-6 indicates the main functional interfaces.



● on-board interface of the Processor Module
▨ via additional interface modules of Advant Controller 160
○ controller external interface
1) only PM645 A, B, C, and PM646
2) only PM644, PM645B and PM645C
3) connected via backplane bus
4) main AF 100 connected via backplane bus and Communication Interface
5) subordinated AF 100 connected via backplane bus and Communication Interface

Figure 3-6. Advant Controller 160 Functional Interfaces

3.1.2 General System Utilities

Appropriate Hardware and Software

Most functions and equipment described as General System Utilities are included in the basic unit of a controller (smallest unit to be ordered) which is loaded with the basic system program. You can enlarge this platform further with alternatives and options.

3.1.2.1 System Clock

Appropriate Hardware and Software

No extra hardware or software is needed.
On PM645 and PM646 external synchronization is possible by a "minute pulse" via the SYNC input at the I/O connector, see Figure 3-7.

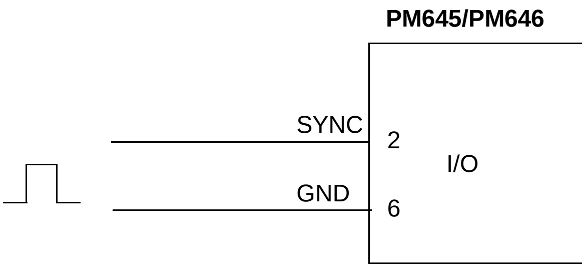


Figure 3-7. External Synchronization of System Clock

Data: see Section B.3, PM645 or Section B.4, PM646.

3.1.2.2 Run/Alarm Relay

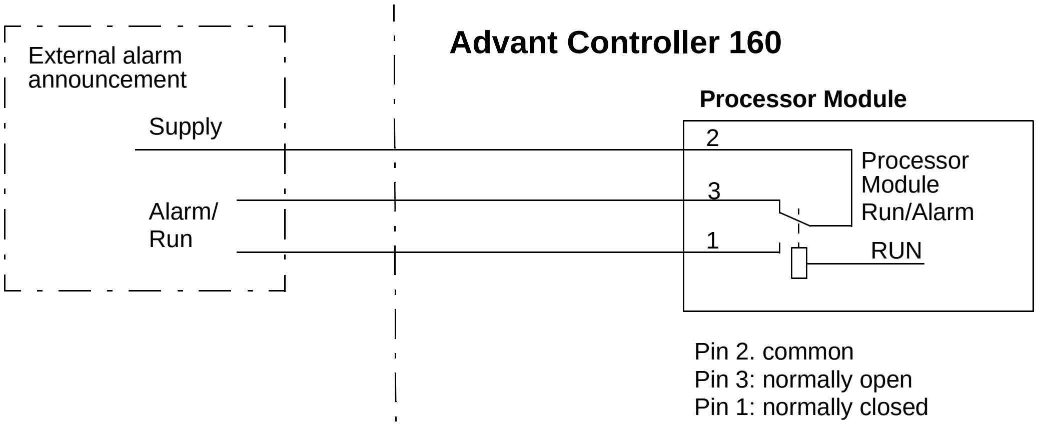
Appropriate Hardware and Software

No extra software is needed.

In case of system shutdown the Run/Alarm relay contact of the Processor Modules is switched automatically according to Figure 3-8.

The relay can be dropped off by setting REL_OFF = 0 in the Processor Module DB element PM645/PM646.

With appropriate wiring, external field power supply can be switched.



Pin 2. common
Pin 3: normally open
Pin 1: normally closed

normal: Processor Module is operational
shown: de-energized, Processor Module not operational

Configuration: not necessary

Figure 3-8. Connection of Run/Alarm Relay

Contact data: see Section B.1, PM640, Section B.2, PM644, Section B.3, PM645 and Section B.4, PM646.

3.1.2.3 Functional Contents

Appropriate Software

The Base Software which is part of the Advant Controller 160 Basic Unit has a functional content in accordance with:

- Logic control and time delays
- Sequence control
- Calendar time functions
- Arithmetic

The above mentioned functions are realized in several PC elements.

For extended functionality several SW options are available.

For more detailed description of the Advant Controller 160 BASE software and the software options see Section 1.8.2.2, Functions of BASE System Software.

3.1.3 Power Supply

System Power Supply

The subracks and modules can be supplied with an unstabilized 24 V d.c. voltage. All other voltages required on the modules are generated by converters on the modules themselves.

It is recommended that you use the mains supply module type SA610 to supply the system:

SA610	input:	a.c. 110 – 240 V or
		d.c. 110 – 250 V
	output:	d.c. 24 V, 2.5 A, 60 W

The SA610 is housed in a standard module enclosure. Install it in the far right position(s) of the station. Each subrack can accommodate a maximum of two SA610, if the power requirement of a station exceeds the capacity of one SA610 module.

The Advant Controller 160 station can also be supplied from an external 24 V d.c. power source. You can use following power supply units:

SA161	input: a.c. 120 V, output: d.c. 24 V, 10 A, 240 W
SA162	input: a.c. 230 V, output: d.c. 24 V, 10 A, 240 W

Connect your external power source to the station's voltage terminals (USA/USB and ZD) on the subracks.

The ZD terminal is directly connected to the metallic frame and to the ground terminal on the subrack.

Use duplicated power supply units to provide redundancy.

You must interconnect the station voltage terminals of the basic and extension subrack of a station with the station voltage cables TK615 (see Figure 2-19).

NOTE

The station does not work reliably if you omit this connection.

Depending on differing needs for circuit breaker capacity, there are different types of power switch and distribution units specified to the individual installations. See the delivery documentation.

Detailed information on, for example, terminal block dispositions, locations, connections between units, and so on, is also given in a circuit diagram enclosed with the controller's delivery documentation.

You can find Information about installation of your power supply in Section 2.2.10, Power Supply Connection. In addition, you can find more detailed hardware descriptions in Appendix C, Cabinet Configuration of this manual and for SA610 in the *S600 I/O Hardware Reference Manual.*

Power Supply for Field Equipment

Auxiliary equipment in the controlled system is normally powered separately. This means separate power supply units and fusing.

Appropriate Hardware

Alternative power supply systems are available. When you order, you can select a suitable alternative. The number of power supply units is calculated with respect to the actual number of I/O modules and subracks.
Normally, you do not have to deal with current consumption calculations.
There are, however, occasions with special requirements, special designs, and so on, when detailed information regarding current consumption is valuable. Please find a description under the heading "Guidelines", below.

Guidelines

- For a summary of the main requirements of the plant supply from a planning viewpoint, see Section 2.1, Site Planning.
- Auxiliary equipment in the controlled system is normally powered separately from the control system power supply. An exception is analog outputs, for example, 0 – 10 V, 4 – 20 mA, which are powered by the system power supply.
- Heavy current on/off loads are **always** powered separately.
- You can use the system power supply for transducers provided that:
  - the need for current is small
  - there is idle capacity in the available power supply units (see **Current Consumption**)
  - the transducer is grounded directly in the control system chassis.

Number of Power Supply Units

The use of the power supply module SA610 (2.5 A d.c.) is recommended for Processor Modules and for S600 I/O. SA610 is housed in the standard S600 module enclosure and occupies one position in the subrack.

2 to 3 power supply modules SA610 are capable of powering a typical basic or I/O station consisting of one or two subracks.

For special utilization of the power supply units, you are advised to calculate the current consumption.

As an alternative you can use power supply units SA161/SA162 (d.c. 24 V, 10 A) especially for building a centralized power supply for several subracks. In addition to SA161/SA162 you can use also SA171/SA172 (d.c. 48 V, 5 A) for field power supply.

Current Consumption

As a rule, 2 to 3 power supply modules are used to supply equipment with one or two subracks (see Table 3-16 within Section 3.2, Capacity and Performance).

Please see *S600 I/O Hardware Reference Manual* for information about the current consumption of the available modules in Advant Controller 160. These tables hold typical data relevant to the actual type of calculation. It also holds power dissipation data to be used in calculating the heat generated in a cabinet. You can use the tables as a form when you make your own calculation.

Detailed information about current consumption of S600 modules you can find in *S600 I/O Hardware Reference Manual* and *S600 I/O Hardware Advant Controller 160 Reference Manual*.

The total static and dynamic loads may under no circumstances exceed 100 percent of the capacity of the supply unit. As all current consumption information is typical and not an "absolute maximum," it is recommended that you not load the supply unit beyond 90 percent of its capacity, including all static and dynamic loads.

Fusing in Distribution Unit

The system is protected with adequate internal fusing. In addition to fusing distributed to different apparatus, there are common miniature circuit breakers in the power switch and distribution units in the cabinets (see the terminal diagram form for the actual power supply system).

The superior distribution fusing unit protects the equipment with respect to:

- Internal fusing in Advant Controller160 (for example SA610)
- Rated current of connected equipment
- In-rush current at power switch-on
- Need to protect the power supply cables to the equipment installed.

The in-rush current at power switch-on must be considered for dimensioning of the fuse. Consequently, you must consider also redundant power supply units connected to the same line for dimensioning of the in-rush current to be considered. Usually, redundant power supply units are connected to separate lines.

3.1.4 Process Interface

3.1.4.1 I/O Systems for Advant Controller 160

An Advant Controller 160 communicates with the process through various types of sensors and actuators connected to the I/O modules. Advant Controller 160 is capable of employing the I/O system:

- S600 I/O
- S800 I/O

Both systems provides high interference suppression. See *ABB Master Environmental Immunity.*

The S600 I/O is used as local I/O system within the controller in the basic station or in the I/O stations.

The S800 I/O is intended to be used as remote I/O system connected to Advant Controller 160 via Advant Fieldbus 100. Cabling represents a large portion of the costs of installing a process control system. In order to reduce this costs the remote S800 I/O system is available covering the most common process signal types.

Process events can be time-tagged. Time tagging can be executed by certain I/O modules itself or by application program. Thus the time accuracy is determined by the selected I/O module type or by the scan time parameter for event detection in the application program.

Both systems S600 I/O and S800 I/O can be connected to Advant Controller 160 simultaneously.

You can find more detailed information of the S600 I/O system in following documents:

- Hardware descriptions and technical data of S600 I/O modules for both Advant Controller 110 and 160:
  S600 I/O Hardware Reference Manual.
- Hardware descriptions and technical data of S600 I/O modules specifically used for Advant Controller 160:
  S600 I/O Hardware Advant Controller 160 Reference Manual

The S800 will not be described in this document. Since the S800 I/O system is common to several Advant Controller products you can find the complete description in separate documents as follows.

- S800 I/O: System description, hardware description and technical data of I/O modules and Advant Fieldbus 100.
  S800 User‘s Guide.

The remote S800 I/O communicate with the controller through Advant Fieldbus 100.

- Advant Fieldbus: System description, hardware description and technical data:
  Advant Fieldbus 100 User's Guide

Functional descriptions, including configuration and application building information on I/O modules and signals, which are applicable to the actual Advant Controller 160, are found in the document.

- Data Base Elements data sheets and configuration:
  Data Base Elements Advant Controller 160, Reference Manual.

General Signal Paths

The input and output signals can be in digital or in analog form (current or voltage signals). Figure 3-9 shows, in principle, the layout of the signal paths for the input and output signals. The signal paths are built up of the following units, which are described in principle below.

S600 I/O:

- External signal cable
- I/O module
- Backplane communication bus
- I/O extension bus with extender modules CI610 and CI615.

S800 I/O:

- External signal cable
- I/O module
- Internal module bus
- Communication module for Advant Fieldbus 100
- Advant Fieldbus 100

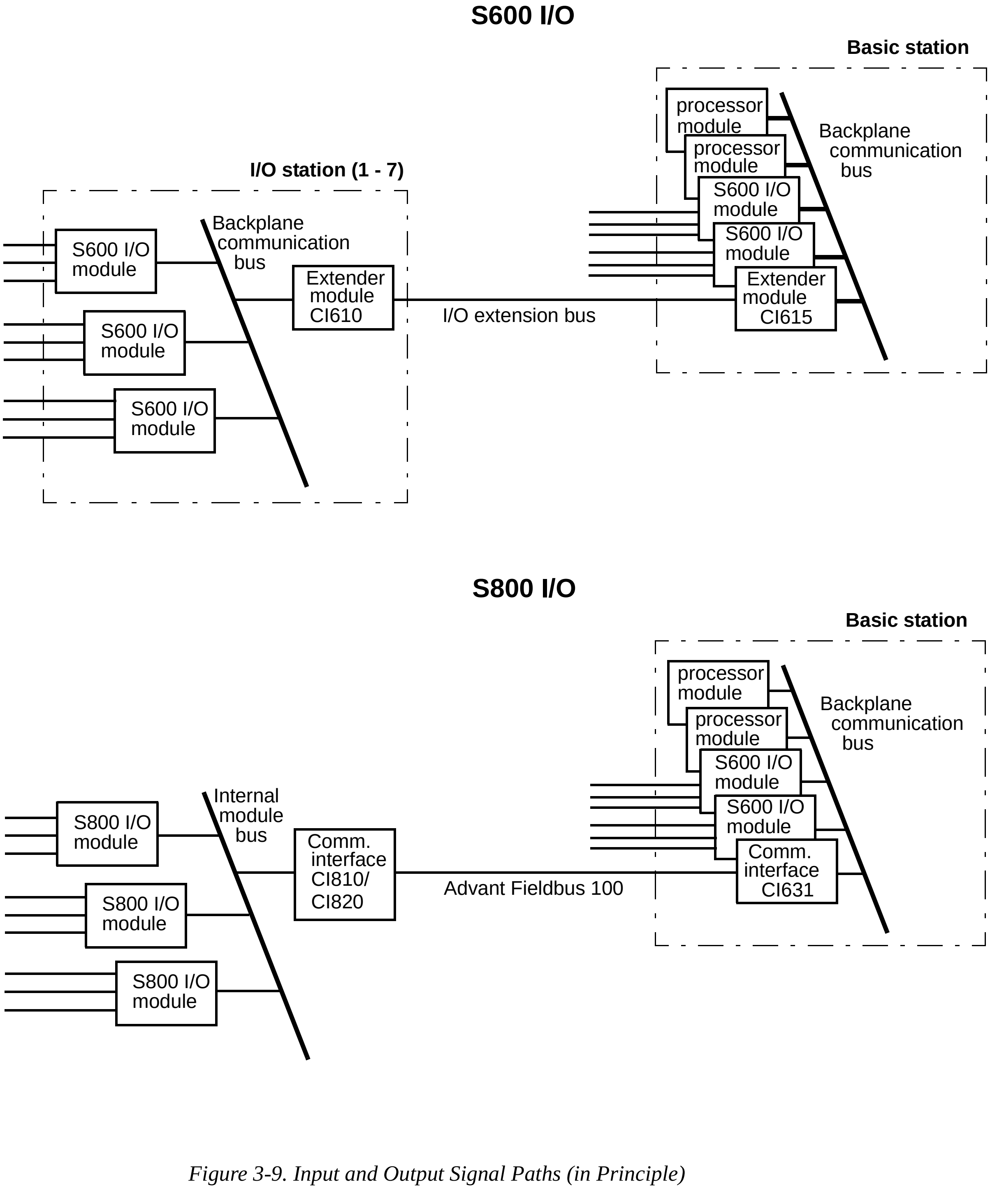


Figure 3-9. Input and Output Signal Paths (in Principle)

External Signal Cable

The process cables can be connected to screw terminals on the process connector of the I/O modules.

Also process connectors with prefabricated cable are available. The connectors can be supplied with different cable length.

I/O Module

I/O modules convert incoming electrical signals from the process controlled, so that they can be further processed in the Processor Modules. Outgoing signals are adapted to their functions in the process. I/O modules are divided into the following groups:

- Digital input modules
- Digital output modules
- Analog input modules
- Analog output modules
- Pulse counter/frequency measurement modules
- Others.

You can exchange I/O modules while the system is running. You can also insert new modules live, provided they are predefined in the data base. A newly inserted module is taken into operation with a certain delay dependent on the CPU load and the number of CPUs and I/O modules. More Processor Modules and more I/O modules can result in an increased delay.

Appropriate Hardware and Software

No extra software is needed. The set of base software (BASE) and the software options OPT2 (MVI support) and OPT3 (event handling), which is always included with Advant Controller 160, is sufficient.

For S600 I/O no extra hardware is needed besides the desired I/O module if a spare slot in a subrack is available.

Supported I/O modules (S600 I/O) are listed in Appendix A, Hardware Components. You can also find information about suitable process connectors, and cables in Section 2.2.14, S600 I/O. Further guidelines are given below.

Interface to Application Program

Each I/O module is normally represented by a *data base (DB) element*. The same applies to the individual channels of the module. For example, for a digital input module in the S600 I/O, there is a superior DI module element and 32 Digital Input channel elements.

The module elements are created by the user as part of the application program. As a result, the data base elements for the individual channels (for example inputs, outputs) appear automatically. In addition for extended functionality extended DB elements are available.

NOTE

I/O modules and I/O channels once configured cannot be deleted or disabled without a shutdown of the whole controller (all processor and I/O modules).

With the given DB element and module type as a reference, you can find functional and hardware descriptions in:

- *Data Base Elements Advant Controller 160 Reference Manual.*
- *S600 I/O Hardware Reference Manual*.
- S600 I/O Hardware Advant Controller 160 Reference Manual.

For use of the combined **Analog Input/Output Module AX645** the following application note must be considered:

Analog Input via AX645

The channel DB elements AXIS645 provide the **analog input values:**

- in Long Integer format 0 – 65 535 = 0 – 23 mA
- with normal input signal range 4 – 20 mA = 0 – 100%.
  Note that the internal representation of percentage values within the PC program is 0 to 100 but not 0 to 1.

For further processing—also for use of the extended DB elements for analog input signals AIS—the input values must be converted into the Real format. Additionally a conversion into the special format which shall be used within the PC program—for example the normally used percentage value—shall be done. The processing chain for these conversions incl. the formula for conversion into the percentage value is shown in Figure 3-10. Note that the given decimal places within the formula are necessary if the accuracy of the input signals as received from the input module shall be maintained. Note that the percentage values 0 – 100% are stored internally as 0 – 100. This is already considered within the given formula.

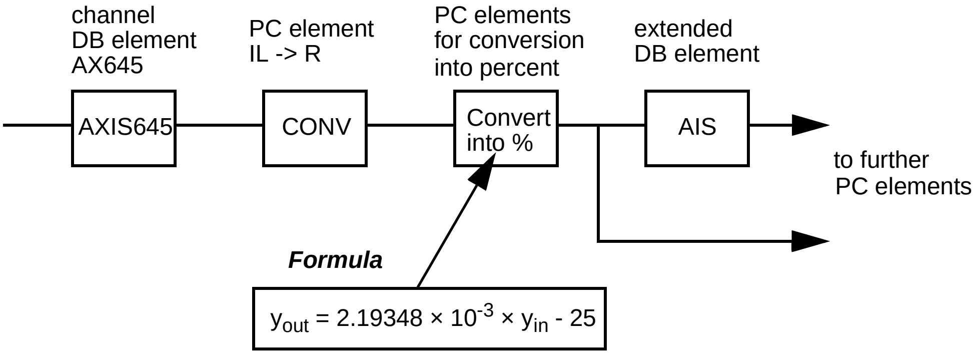


Figure 3-10. Processing Chain for Analog Input from AX645

Analog Output via AX645

The channel DB elements AXOS645 needs the **analog output values**:

- in Long Integer format 0 to 16,383 = 0 – 23 mA
- with normal output signal range 4 – 20 mA (0 to 100 percent). Note that the internal representation of percentage values within the PC program is 0 to 100 but not 0 to 1.

Normally the analog output signals as generated by the PC program are in Real format. If the extended DB element for analog output signals AOS shall be used the PC program *must* provide them in Real format. Therefore the output values must be converted into Long Integer format. The processing chain for these conversions incl. the formula for conversion from the percentage format is shown in Figure 3-11. Note that the given decimal places within the formula are necessary if the accuracy of the output signals as provided by the output module shall be maintained. Note that the percentage values 0 – 100% are stored internally as 0 – 100. This is already considered within the given formula.

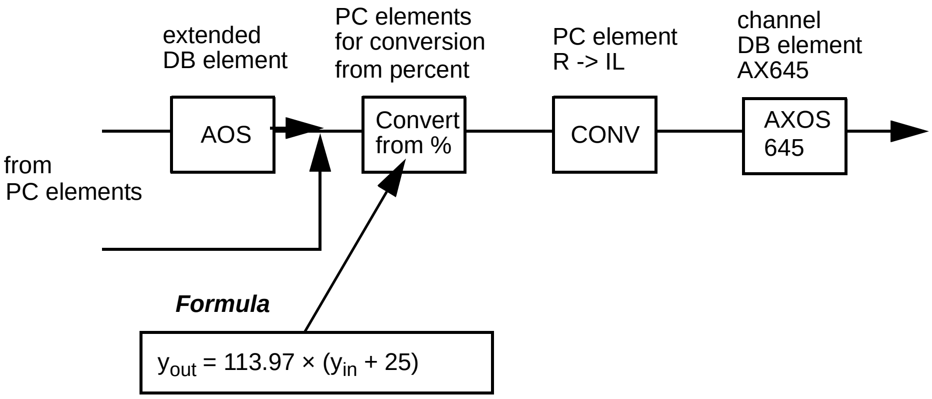


Figure 3-11. Processing Chain for Analog Output to AX645

Guidelines

The following Section 3.1.4.2, S600 I/O System guides you in selecting suitable I/O for an application and some design rules.

I/O in the basic station

Free slots in the subracks of the basic station may be used for the installation of I/O modules. Depending on the configuration there are up to 17 slots available for I/O modules in a basic station.

I/O in an I/O station

If the slots of the basic station are occupied and there is still a need for more I/O modules, those I/O modules can be installed in up to 7 I/O stations (each with up to two subracks). An example is shown in Section 1.8.1.4, Example of Advant Controller 160 System Structure.

With respect to programming, I/O modules in an I/O station behave like those is in the basic station. Timing and reaction time is the same, too.

Note that the length of the I/O extension bus between basic station and I/O stations must not exceed 20 m in total.

3.1.4.2 S600 I/O System

Guidelines—General

There are certain restrictions in number of I/O subracks, number of I/O modules and number of signals. Please see Section 3.2, Capacity and Performance.

There are no restrictions on mixing of I/O modules of different categories in a subrack. There are, however, some production rules to facilitate ordering and rapid delivery. See Section 2.1.4, Standard Layout and Disposition of Cabinets.

When you design a control system, it is desirable to leave some spare capacity. It is practical to have approximately 10% to 20% of the channels as spares. The same recommendation is valid for spare space in subracks.

You can add new I/O modules on-line. The corresponding data base module elements you can add also to your application program on-line.

Guidelines—Analog Inputs

General

With current signals and series coupling of loads, the total resistance may not exceed the resistance through which the sensor output can be driven.The analog inputs are scanned by the Processor Modules using these inputs just before the execution of a program module (for example control module). Thus the update rate depends on the cycle time of the corresponding control module programmed in the application program.

AI610

32 single-ended, non-isolated inputs for connection of non-grounded sensors. Input range 0 – 20 mA. With serial connection of loads in a current loop, there must be only one grounding point. This means that loads which are connected in series with AI610 must be differential or isolated from ground. Connection of a transmitter to AI610 see Figure 3-12.

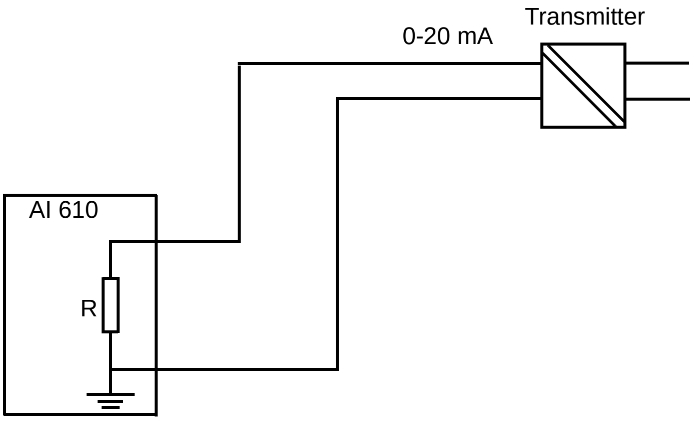


Figure 3-12. Connection to AI610

When voltage signals are connected in parallel, grounding is to be at one point only, the ground point in the AI610.

AI625

16 single-ended inputs with common ground, isolated from the system as one group, common mode voltage 50 V. Transmitter supply is provided by the I/O module. Input range 4 – 20 mA. These are used for the connection of non-grounded sensors which shall be isolated from the system.

AI620

16 differential inputs for individually grounded sensors, common mode voltage 100 V. Input range 0 to 20 mA, 4 to 20 mA, -20 to +20 mA, -10 to +10 V. These are used when it is necessary to ground measurement circuits at different places in the system. This means you can use transducers which require grounding of the signal zero.

AI630

12 inputs for resistors or Pt 100 transducers, connected with three-wire or four-wire. Input range 0 to 500 Ω or -200 to +600 °C. The inputs are isolated from the system as one group.

AI635

14 differential inputs for millivolts or thermo elements and 2 inputs for ambient (CJ) temperature measurement with Pt 100, common mode voltage 100 V. Input range -5 to +25 mV, -10 to +50 mV, -15 to +75 mV, -25 to +150 mV, thermo elements type B, C, E, J, K, N, R, S, and T. Both grounded and non-grounded thermo elements can be used.

AX646

16 analog input channels isolated from the system as one group, short-circuit and open-circuit proof. The 16 analog output channels will be switched over periodically to the related inputs for input tests. The output channels are not available for the user. Input range 4 to 20 mA.

Guidelines—Analog Outputs

AO610

16 outputs, isolated from the system as one group, short-circuit and open-circuit proof. Output range 0 to 20 mA or 0 to 10 V. The load resistance of a current output is 600 Ω maximum.

AO650

8 outputs, each output separately isolated, short-circuit and open-circuit proof. Output range 0 to 20 mA, 4 to 20 mA, -20 to +20 mA, 0 to 5 V, 1 to 5 V, 0 to 10 V, -10 to +10 V. The load resistance of a current output is 600 Ω maximum.

Guidelines—Analog Input/Output

AX645

16 channels, each configurable as input or output, isolated from the system as one group, short-circuit and open-circuit proof. Fast input/output: 2 to 7 ms cyclic update with 8 activated channels. Output signal supervision. Input/output range 4 to 20 mA.

Note that for signal value input/output between PC program and AX645 specific conversions are to be configured. See Section 3.1.4.1, I/O Systems for Advant Controller 160, heading Interface to Application Program.

Guidelines—Digital Inputs

All the S600 digital input modules have one or several inputs for monitoring the external supply voltage UP. The digital inputs are scanned by the Processor Modules using these inputs just before the execution of a program module (for example control module). Thus the update rate depends on the cycle time of the corresponding control module programmed in the application program.

Some of the S600 digital input modules can be configured for pulse catching or event recording, too. Pulse catching means selectable filtering as well as prolongation of positive input pulses. Event recording means the recording of changes of the input signal together with a time stamp. The time stamps of the S600 I/O modules have a resolution of 1 millisecond.

DI610

32 non-isolated inputs. Input voltage 24 V d.c.

DI620

32 inputs, isolated in four groups. Input voltage 24 V d.c.

DI621

32 inputs, isolated in four groups. Input voltage 48 V d.c.

DI622

32 inputs, isolated in four groups. Input voltage 60 V d.c.

DI635

16 inputs, isolated in four groups. Input voltage 120 V a.c.

DI636

16 inputs, isolated in four groups. Input voltage 230 V a.c.

DI650

32 inputs, isolated in four groups. Input voltage 24 V d.c. Can be configured for pulse catching and event recording.

DI651

32 inputs, isolated in four groups. Input voltage 48 V d.c. Can be configured for pulse catching and event recording.

DI652

32 inputs, isolated in four groups. Input voltage 60 V d.c. Can be configured for pulse catching and event recording.

DI685

32 inputs, isolated. Input voltage 24/48 V d.c. Internal 48V sensor power supply, wire break supervision and event recording.

Guidelines—Digital Outputs

The S600 digital output modules have solid state (semiconductor) or relay outputs. The different output types have partially different properties. Certain significant properties are presented below:

- Solid state outputs
  These generally have a long operational life time, even with a high switching frequency.
- Relay outputs
  These have a shorter operational life time than solid state outputs. When the output is frequently changed, it is subject to wear and its life time is shortened. They can withstand occasional higher voltage. Different system voltages can be accommodated on the same board. A certain degree of inductive load can be accepted. Small load currents with low voltage (< 40 V) can give contact problems.

DO610

32 solid state outputs, non-isolated, with short-circuit protection. Output 24 V d.c., max. 200 mA. The module has an input for monitoring the external supply voltage UP.

DO620

32 solid state outputs, isolated in four groups, with short-circuit protection. Output 48 V d.c., max. 500 mA.

DO625

16 solid state outputs, isolated in eight groups, with short-circuit protection. Output 24 V d.c., max. 2 A.

DO630

16 relay outputs, each output separately isolated. Output 24 to 250 V a.c./d.c., max. 2 A. Breaking capacity is 500 VA for a.c. loads and 40 W for d.c. loads.

DX610

6 relay outputs, each output separately isolated. Output ≤ 60 V d.c., max. 2 A. Breaking capacity is 120 W for d.c. loads.

Guidelines—Pulse Counting

DP620

5 counters for up to 100 kHz, each with inputs A, B, Strobe and Set (24 V only). Each input is separately isolated.

DP640

1 main rotational speed signal input with overspeed trip signal output, 50 kHz.
Second speed signal input for detection of the direction of the main wheel or for second wheel with reduced supervision. All I/O are isolated from the system as one group.

Overspeed trip signal output via solid state (24 V/100 mA) or relay contact output (24 V/1.1 A d.c., 60 V/0.5 A d.c., 220 V/2.4 A a.c.).

3.1.5 Communication

3.1.5.1 Provided Link Types

Communication Survey

The table below shows the communication links available for Advant Controller 160 and the systems you can connect to. You can find more detailed information for each link in the following subsections.

Table 3-1. Communication Survey

Equipment	Used link(s)	Functionality (explanations below) (1)
Advant Controller 410/450	Advant Fieldbus 100, RCOM, RCOM+	R, I, B, E
Advant Controller 160	Advant Fieldbus 100, RCOM, RCOM+	R, I, B, E
Advant Controller 160	High speed link (PM645,PM646)	R, I, B
Advant Controller 110	Advant Fieldbus 100, RCOM, RCOM+	R, I, B, E
Advant Controller 70	Advant Fieldbus 100	R, I, B, E
Advant Controller 55	RCOM, RCOM+	R, I, B, E
MasterPiece 200/1	RCOM	R, I, B
S600 I/O	Bus Extension to S600 I/O	R, I, B, E (2)
S800 I/O	Advant Fieldbus 100	R, I, B
Advant Station 100 Series Engineering Station	Serial interface of PM640/PM644/ PM645/PM646, Advant Fieldbus 100	(3)
AdvaSoft 2.0	Advant Fieldbus 100	R, I, B, E
Local Operator Station / HMI	Modbus	R, I, B (4)
Other manufacturers' equipment	Siemens 3964, Modbus	R, I, B
PROFIBUS slaves (Distributed Peripheral Modules, DPM's)	PROFIBUS-DP	R, I, B

(1) **R**, **I**, **B** indicates Real, Integer and Boolean data, respectively. Bi-directional information flow is possible. **E** indicates handling of time-stamped events.
(2) Read/write process I/O data, configuration data of I/O modules
(3) Configuration data transfer, application program loading and commissioning functions.
(4) Processor Module is slave on the Modbus.

Data Set Peripherals

Information is exchanged between separate controllers (and between a controller and other equipment indicated in Table 3-2) by means of "Data Set Peripherals" (DSP), messages containing aggregates of data base information. DSPs are explicitly specified in the communicating controllers, as part of the application programming. With a DSP, the communication normally transmits data cyclically between the nodes. The cycle time is selectable from 2 ms upwards. In addition to Data Set Peripherals, other variants exist, for example MVI Data Block (MVB).

For a detailed description of Data Set Peripheral, see the manual *AMPL Configuration Advant Controller 100 Series Reference Manual*.

Appropriate Hardware and Software

From a hardware viewpoint, the concept of Communication Interface submodule and submodule carrier is used to build a function. Please refer to Section 2.2.14.2, Assembly for a description. For information on the possible number of instances, please see Section 3.2.5.1, Provided Link Types.

Table 3-2. Link Types, Hardware and Software for Advant Controller 160

Link Type	Communication Interface Module	Software Option	Comments
Advant Fieldbus 100	For coax bus cable: CI626 (non redundant) or CI630 or 2× CI630 For twisted pair bus cable: CI627(nonredundant) or CI631 or 2× CI631	No	2×4 modules CI630 for redundant interface 2×4 modules CI631 for redundant interface (only subordinate AF100).
Bus extension to S600 I/O	For basic station: CI615 or 2× CI615 For I/O station: CI610 or 2× CI610	No	Usable for non red. and redundant configuration.

Table 3-2. Link Types, Hardware and Software for Advant Controller 160 (Continued)

Link Type	Communication Interface Module	Software Option	Comments
High speed link	PM645 or PM646	OPT6 (1) needed for station redundancy and rotational speed measurement	Usable for: – PM645 or PM646 in same or separate controllers – redundancy (planned and unplanned tracking) – general signal exchange
PROFIBUS-DP	PM644	–	–
RCOM	Submodule CI532V01 + submodule carrier SC610	OPT2 (1) (MVI support)	–
MODBUS (slave function only)	using second serial interface at Processor Module PM640 or PM644 or PM645 or PM646	OPT4 (Modbus I driver)	Processor Module is slave on Modbus. Only point-to-point link (RS 232C)
MODBUS	submodule CI532V02 + submodule carrier SC610	OPT2 (1) (MVI support)	–
SIEMENS 3964R	submodule CI532V03 + submodule carrier SC610	OPT2 (1) (MVI support)	–

(1) Included within BASE system software.

Guidelines – Location of Hardware

Please refer to Section 2.2.14.2, Assembly for a detailed information.

Guidelines – Multi Vendor Interface (Standard Protocol)

- Communication Interface CI532V0x has two ports. Both ports have the same protocol.
- Submodules of type CI532V0x fits into submodule carrier SC610.
- CI532V0x is delivered with a standard protocol: RCOM, Modbus, Siemens.
  Different protocols are sold as different articles: CI532V01, CI532V02, CI532V03.
  “V” stands for variant.

3.1.5.2 Applied Communication

Interface to Application Program

Table 3-3. Applied Communication, Used Links and Interface to Application Program

Equipment	Used Link(s)	Software Interface within Advant Controller 160	
		Link DB Elements	**Application DB elements**
Advant Controller 410/450	Advant Fieldbus 100	CI626/CI627, CI630/CI631	DSP, DAT
	RCOM, RCOM+	SC610, CI532, MVICHAN, MVINODE	MVB, DAT
Advant Controller 160	Advant Fieldbus 100	CI626/CI627, CI630/CI631	DSP, DAT
	RCOM, RCOM+	SC610, CI532, MVICHAN, MVINODE	MVB, DAT
Advant Controller 160	High speed link for unplanned data exchange (unplanned tracking)	PM645/ PM646	Not needed
	High speed link for planned data exchange	PM645/ PM646	HSLR HSLS
Advant Controller 160	Backplane bus for communication between Processor Modules within the same controller	–	MDAT, MDATS
Advant Controller 110	Advant Fieldbus 100	CI626/CI627, CI630/CI631	DSP, DAT
	RCOM, RCOM+	SC610, CI532, MVICHAN, MVINODE	MVB, DAT

Table 3-3. Applied Communication, Used Links and Interface to Application Program (Continued)

Equipment	**Used Link(s)**	**Software Interface within Advant Controller 160**	
		Link DB Elements	**Application DB elements**
Advant Controller 55	RCOM, RCOM+	SC610, CI532, MVICHAN, MVINODE	MVB, DAT
MasterPiece 200/1	RCOM	SC610, CI532, MVICHAN, MVINODE	MVB, DAT
S600 I/O	Bus Extension to S600 I/O	for basic station CI615 for I/O station CI610	I/O element
S800 I/O	Advant Fieldbus 100	CI631/CI627	I/O element
Advant Station 100 Series Engineering Station	First serial interface (Com A) of PM640, PM644, PM645 or PM646	Not needed	Set of commands, Configuration data
AdvaSoft for Windows	Advant Fieldbus 100	CI626/CI627, CI630/CI631	DSP, DAT
	RCOM+	SC610, CI532, MVICHAN, MVINODE	MVB, DAT
Local Operator Station / HMI	Modbus I (slave function). At second serial interface (Com B) of PM640, PM644, PM645, or PM646	MODCHAN	DAT
Other manufacturer‘s equipment	MultiVendor Interface (for SC610) - Modbus - Siemens 3964R	SC610, CI532, MODCHAN	MVB, DAT

Table 3-3. Applied Communication, Used Links and Interface to Application Program (Continued)

Equipment	Used Link(s)	Software Interface within Advant Controller 160	
		Link DB Elements	Application DB elements
PROFIBUS slaves (Distributed Peripheral Modules, DPM's)	PROFIBUS-DP	PM644, PB	PBS

Guidelines—DataSet Peripheral Communication

Data Set Peripherals (DSP) are used with signal exchange between, for example, controllers. A DSP is defined by a data base element which states the cycle time and from where the information is received or to where it is transmitted. The data base element for a DSP also refers to a number of DAT elements. These DAT elements contain, in turn, the values which are to be transmitted/received.

When names are allocated to a DSP and to associated DAT elements, it is important to be able to trace the origin of the data, that is, where the data originates. One way is to give a DSP a name in accordance with DSP "from node number" – "to node number". If a DSP is transmitted from node 12 to node 11, it is given the name DSP12-11. Associated DAT elements can be given the name DSP12-11.R1 (which is obtained automatically if a real DAT element is created with the help of DSP).

As an alternative, you can give DAT elements symbolic names (of up to 12 characters).

Information about **performance** given in Section 3.2, Capacity and Performance shows that increasing the number of DSP causes more load than increasing the number of DATs. Thus you should minimize especially the number of DSP.

3.1.5.3 I/O Bus Extension

Outline Description

If an Advant Controller 160 system needs more than two subracks, it can be extended by adding I/O stations. Adding I/O stations to a basic station necessitates bus extenders and bus extension cables. I/O extension modules are also used, where the physical distribution of a system requires that I/O modules be accommodated in different cabinets.

An extension bus can be up to 20 meters long, branches and radial configurations are not permitted. A bus terminator must be mounted in the last I/O station at the end of the bus extension cable. The termination at the near end is included in the bus extender CI615.

Figure 3-13 shows an Advant Controller 160 configuration with two I/O stations.

To obtain higher availability, this installation can be made redundant, by using two CI615 in the basic station, two CI610 in each I/O station and two bus extension cables per I/O station. This is shown in Figure 3-14. For simplification the stations are shown without possible extension subracks. The optional SA610 power supply modules are not shown as well.

NOTE

A single CI615 may not be inserted or removed while the application program is running. Before the I/O extension bus cable TK610 must be removed from the CI615.

In case of a redundant CI615 configuration a switch-over may take more than 1 sec (worst case). I/O modules in the corresponding I/O station are not accessible during this switch-over!

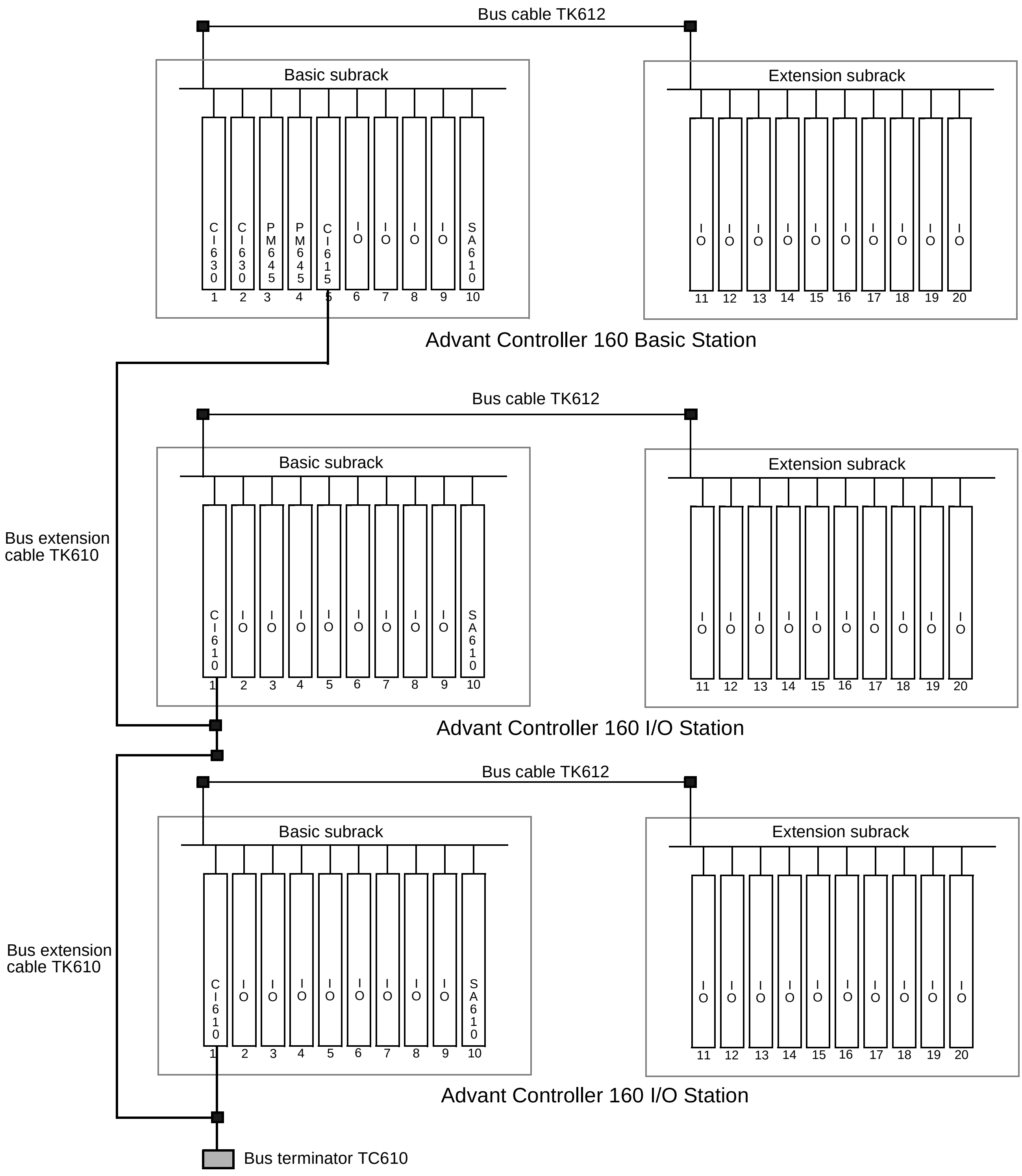


Figure 3-13. Example of an Advant Controller 160 Configuration with Two I/O Stations and Non Redundant I/O Extension

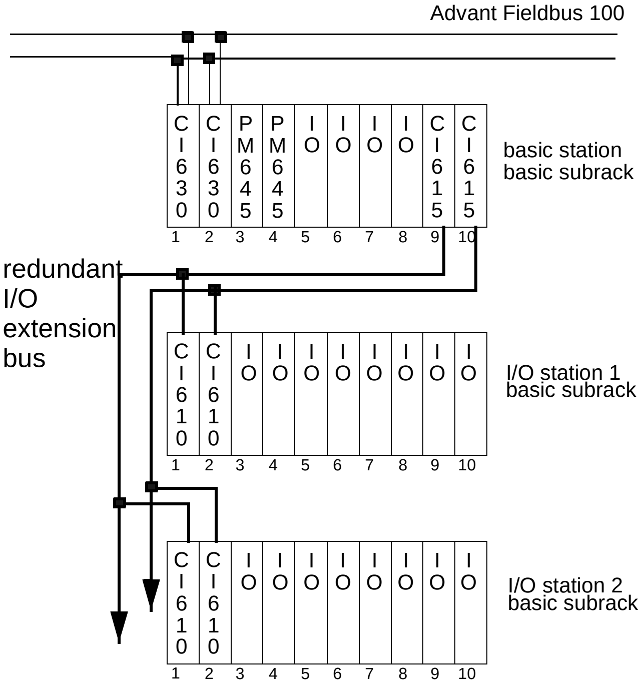


Figure 3-14. Advant Controller 160 Configuration with Two I/O Stations and Redundant I/O Extension

Bus Extender CI615 for Basic Station

The bus extender CI615 enables you to add up to seven I/O stations, via the I/O extension bus, to a basic station. Only one CI615 module (non redundant configuration) or a redundant pair can be mounted in a basic station.

The main functions are:

- Data transmission from the Processor Modules to the I/O modules and vice versa
- Termination of extension bus
- Detection of open-circuit cables.

Bus Extender CI610 for Advant Controller 160 I/O Station

The bus extender CI610 connects an I/O station via the I/O extension bus to the basic station. For redundancy two modules CI610 can be used per I/O station. A CI610 can be addressed and configured by the Processor Module in the same way as any I/O module.

The main functions are:

- Data transmission from I/O extension bus to the I/O station
- Station address decoding
- Supervision of data transfer

- System power supply supervision.

This section gives you an overview of bus extension. You can find more detailed technical information about CI615 and CI610 in following document:

- S600 I/O: Hardware descriptions and technical data of I/O modules: *S600 I/O Hardware Reference Manual* and *S600 I/O Hardware Advant controller 160 Reference Manual.*

3.1.5.4 Advant Fieldbus 100

Outline Description

Advant Fieldbus 100 (AF 100) is a high-performance bus specially designed for real-time applications. A number of different products are connectable to Advant Fieldbus 100, that is, Advant Controller 410/450, Advant Controller 160, and so on. It features reliable, cyclic data transfer (using Data Sets) as well as demand-driven background transfer of service data. Advant Fieldbus 100 also features a distributed bus master scheme. If one or several controllers are lost, the bus is not affected and operations continue.

For increased availability, you can duplicate the cables and modems (physical redundancy).

The transmission speed of the bus is 1.5 Mbit/s, and the code is Manchester Biphase L with a code violation preamble and CRC check according to IEC TC57. The transmission quality and frame length are supervised. The above features guarantee a Hamming distance of d = 8.

Advant Controller 160 supports communication with 4 independent Advant Fieldbus 100.

There are 4 types of Advant Fieldbus 100 Communication Interface modules usable for Advant Controller 160.

For coaxial cable:

- CI626 and CI626V1 usable as non redundant interface
- CI630 usable as non redundant (1 module) or redundant interface (2 modules).

For twisted pair cable (only subordinated AF 100):

- CI627 usable as non redundant interface
- CI631 usable as non redundant (1 module) or redundant interface (2 modules).

NOTE

If CI630 and/or CI626V1 and/or CI631 and/or CI627 are used, media redundancy is fully supported.

If CI626 is used, coaxial media redundancy only is supported, with restrictions in cable length difference between the two redundant cables. With optical bus cable, only one physical bus line is possible.

CI630 and CI631 incorporate a supervision function which detects when a Processor Module ceased to write DSPs. Therefore, the cycle time of the PCPGM must not be slower than then fastest DSP.

Advant Fieldbus 100 has a physical layer comprising a coaxial cable with a BNC T-adaptor connected to the CI626 or CI630 Communication Interface over a short drop cable. A cable with 80 nodes can be driven by the interface. With an inexpensive 75 Ω CATV cable with 7 mm diameter, a 300 m cable length is possible. With 11 mm diameter cable, you can have a cable length of 700 m. A foil screen is essential to minimize radiation (see Product Guide for cable specification). The coaxial cable must be terminated by 75 Ω terminators at both ends.

The BNC T-adaptor can be connected to, or disconnected from, the Communication Interface without disturbing the communication between the other nodes on the bus. Using redundant communication links, data is transferred via both by automatically switching between the lines. In case of a disrupted line, the Communication Interfaces are switching to the intact line.

Together with the opto-modem TC630 and opto-fibre cable, you can extend the bus length up to 1700 m. With opto-fibre cable redundant bus lines can be configured too.

The only difference between CI627/CI631 and CI626/CI630 is the physical layer. CI627/CI631 uses twisted pair instead of coaxial cable. You can have a cable length of opto 700m for twisted pair too.

An AF 100 repeater modem TC513 is used as an interface between AF 100 coaxial cable medium and AF 100 twisted pair medium which is used to connect an Advant Controller 70. Note that Advant Controller 70 also supports redundant twisted pair bus lines.

The AF 100 repeater modem TC514 is used as an interface between AF 100 twisted pair cable medium and AF 100 optical medium and the AF 100 repeater modem TC515 is used for repeating twisted pair cable.

Data exchange on Advant Fieldbus 100 is maintained by DB element DataSet Peripheral (DSP). Please refer to the manual *Data Base Elements Advant Controller 160 Series* for further description of this element.

The number of DSPs (send and receive) is limited to 200 per Processor Module for each Communication Interface. A total number of 400 DSPs (send and receive) can be assigned per communication module.

Dual Advant Fieldbus 100 Configuration

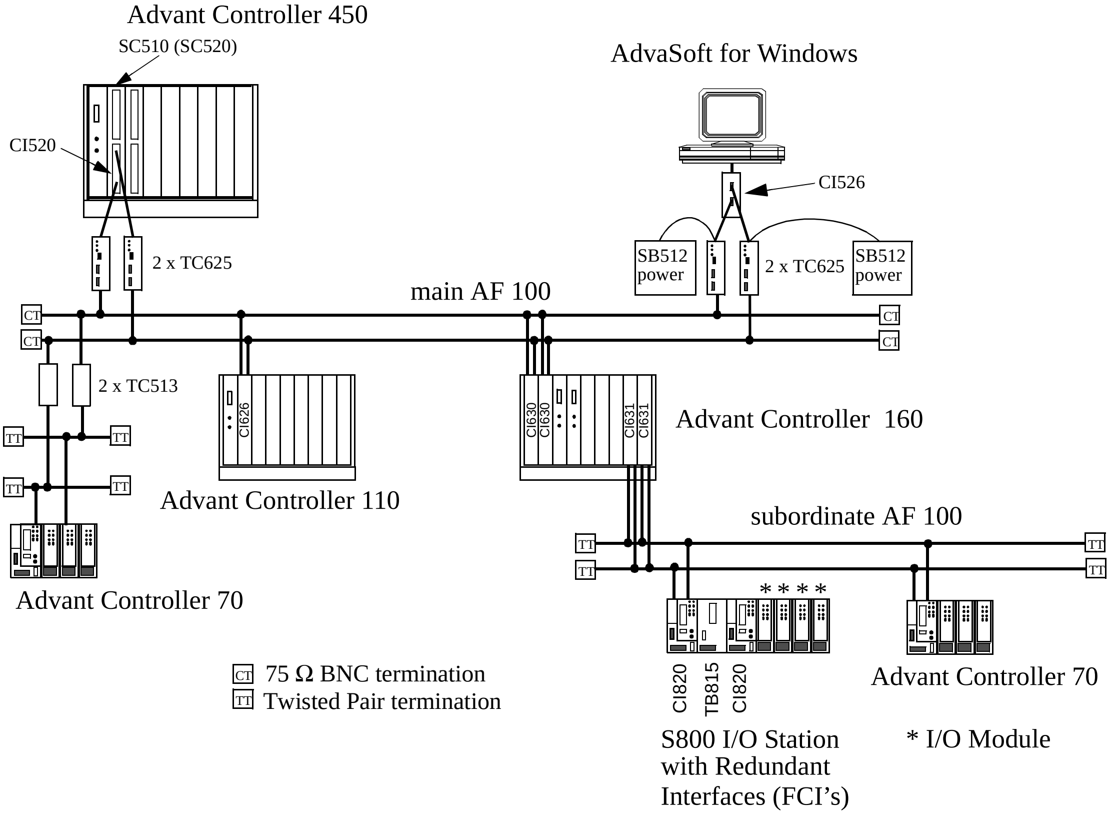


Figure 3-15. Dual Advant Fieldbus 100 Configuration

4x Advant Fieldbus 100 (one Redundant)

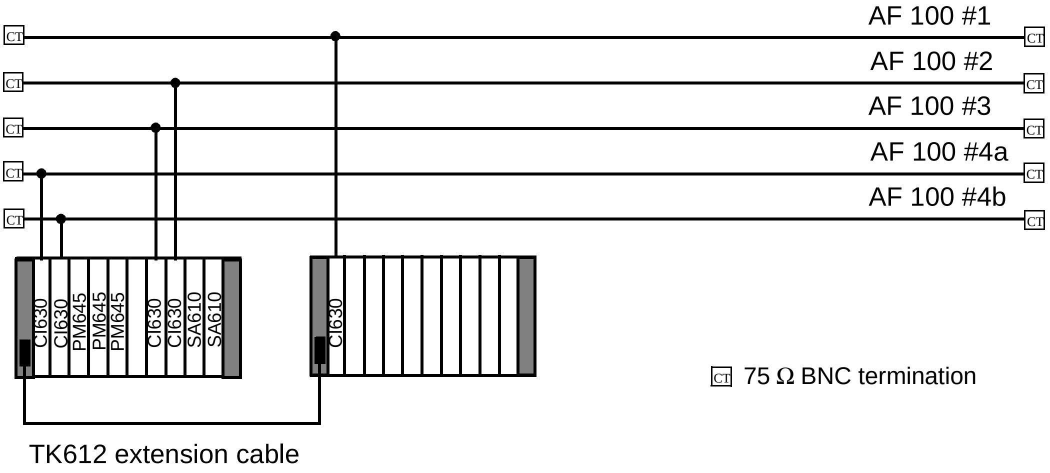


Figure 3-16. 4x Advant Fieldbus 100 (one Redundant)

CI626, CI627, CI630, CI631

The main function of the Communication Interfaces CI626, CI627, CI630, and CI631 is service and process data exchange between Advant Controller 160 and Advant Fieldbus 100. All CIs can be bus master. For an Advant Controller 160 equipped with only one Processor Module, all CIs can be time synchronization master as well. However, only CI630 product revision Q or higher can be time synchronization master if several Processor Modules are in one station.

NOTE

A CI626 or a CI630 is used for internal data management tasks in Advant Controller 160. Therefore each Advant Controller 160 must contain at least one CI626 or CI630 in position 2 of a basic station.

All CIs can be used as non redundant Communication Interfaces to Advant Fieldbus 100. Two CI630 or two CI631 can be used as redundant Communication Interface to Advant Fieldbus 100. All Communication Interfaces must be placed in the basic station. Each basic station can contain up to 8 Communication Interfaces:

- 2 redundant Communication Interfaces in position 1 and 2
- 6 Communication Interfaces in position 9 to 20 (positions 3 to 8 cannot be used).

All Communication Interfaces (CI626, CI627, CI630, and CI631) can be used in the same Advant Controller 160. CI626 and CI630 can be used in the same AF 100 network.

Data transfer on Advant Fieldbus 100 is controlled by the bus master through polling of the bus nodes. The bus master function can be enabled or disabled by setting the attribute MASTER at the DB element (CI626, CI627, CI630, CI631).

You can find more detailed technical information about CI626, CI627, CI630, and CI631 in following documents:

- *S600 I/O Hardware Reference Manual.*
- *S600 I/O Hardware Advant Controller 160 Reference Manual.*

Time Synchronization

The time synchronization facility enables the cyclic synchronization of the internal clocks of controllers and stations within one AF 100 system. See Section 3.1.12, System Clock Synchronization.

A resolution of 1 ms and an over all accuracy of ≤ 10 milliseconds is achieved.

Communication with DSP

Communication between Advant Controller 160/Advant Controller 400 stations via Advant Fieldbus 100 is accomplished by Data Set Peripheral (DSP) data base elements.

In both communication partners, a DSP must be configured with references to DAT elements. Both DSPs have the same configuration values, except the SOURCE attribute.

Note that DSPs once configured only can be deleted with shutdown of the complete control bus Advant Fieldbus 100.

3.1.5.5 HSL Communication between PM645 or PM646 Modules

Application

Several Processor Modules PM645 or PM646 can communicate with one another via its high speed serial links (HSL). The communication can be used for:

- transmission of tracking values for redundancy synchronization
- exchange of sensor signals between independent channels set up in separate controllers (for example turbine or boiler protection) and
- exchange of signals for general application.

The communicating Processor Modules can be located within one common station or within separate stations. Each Processor Module has two high speed serial links and therefore can communicate with up to two other Processor Modules (see Figure 3-17).

The maximum amount of data which can be transmitted are:

- 128 values of each data type B, I, IL, R for planned tracking, signal exchange for protection and general application and
- 5 kByte per control task, but maximum 32 kByte per Processor Module for unplanned tracking (system-based redundancy synchronization)

The data are transmitted cyclically with the cycle time of the control task which generates the data to be sent. The transmission rate is sufficiently high that for example the maximum amount of data which can be transmitted (that is 128 real + 128 long integer + 128 short integer + 128 binary data) can be transmitted within 4 ms.

Communication for unplanned tracking is only possible via HSL1, communication for planned tracking or general signal exchange can be done via both HSL1 and HSL2. Also in case of unplanned tracking HSL1 and HSL2 can be used for planned data exchange additionally.

Operation

Each high speed serial link consists of two half-duplex serial communication lines. Therefore each CPU uses four HSL channels: two transmission and two receive channels. The sent data are the same data on both links because it is sent out in parallel. Concerning the shown configuration with three Processor Modules (Figure 3-17) this means that each CPU sends the same data to both other CPUs.

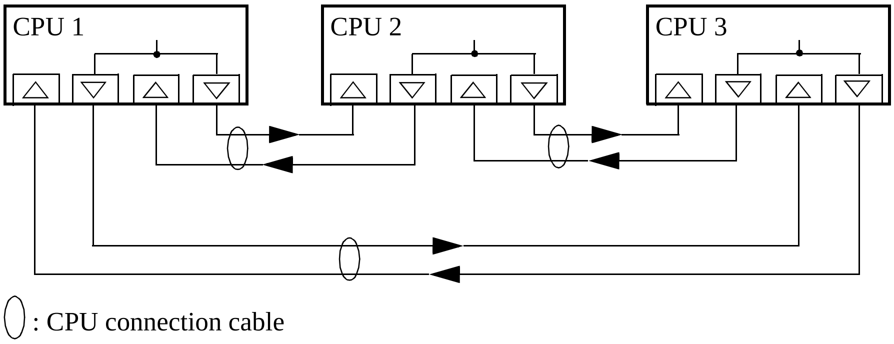


Figure 3-17. Data Transmission via HSL with Three CPUs

The data are sent cyclically with the cycle time of the control tasks providing the data. The actual data are sent at the end of the processing cycle of the control tasks. The control tasks within the receiving Processor Module read the data sent at the beginning of their processing cycle.

For more detailed configuration information see Section 3.1.11.6, 1 out of 2 CPU Redundancy Configuration.

Diagnostic features of the HSL communication

The Processor Modules PM645 or PM646 contain diagnostic functions for detection of disturbances of the physical layer and failures of the communication partners.

The physical layer of the used HDLC protocol is secured through a cyclic redundancy check (CRC).

A life signal is sent via the HSL if no transmission has been requested within 25 msec. When a Processor Module has not received any data within 100 msec, the HSL is considered as disturbed. Planned HSL data are supervised for cyclic receiving (application data time-out) and will be checked for retransmitted, non-updated data blocks (frozen application data).

All detected errors are written into the error buffer for access by the engineering tool of AdvaBuild for Windows Function Chart Builder. Additionally the HSL specific DB elements report these errors via its error terminals.

During initialization of the Processor Module the amount of planned data via HSL is checked. Per control task not more than 5 kByte and per Processor Module not more than 32 kByte is allowed. If one of these values is exceeded, HSL communication is not started. In case of redundant configuration switchover to a slave is blocked. The error message "memory allocation failure" is included in the error buffer of both slave and master. The maximum number of values configured for planned data exchange is already checked by the tool during configuration.

DB elements for HSL Communication

- The DB element **PM645/PM646** is to be used to configure if the HSL communication shall be used for unplanned tracking for redundancy synchronization. Unplanned tracking needs no further configuration for the HSL communication. Planned HSL communication for redundancy or general signal exchange is possible in addition to unplanned tracking.
- The DB elements **HSLS** and **HSLR** (**H**igh **S**peed **L**ink **S**end, **R**eceive) are used for configuration of planned data transfer via HSL. The data type (**B**oolean, **I**nteger, **I**nteger**L**ong, **R**eal) is specified at terminal DATATYPE.

3.1.5.6 RCOM

Outline Description

RCOM (Remote COMmunication) enables Advant Controller 160 to communicate/transmit data to other units over long distances via a serial V24/RS 232C asynchronous communication bus.

RCOM+ is an RCOM protocol type with safer CRC check and no "Break" character in the transmission telegrams. RCOM+ is able to transfer MVI Data Blocks (MVB) with up to 24 DATs instead of up to 8 DATs in case of RCOM.

You can connect the following Advant OCS product lines and other equipment to Advant Controller 160:

- Advant Controller 55 (RCOM, RCOM+)
- Advant Controller 70 (RCOM, RCOM+)
- Advant Controller 100 Series (RCOM, RCOM+)
- Advant Controller 400 Series (RCOM, RCOM+)
- MasterPiece 200/1 (RCOM)
- Older types of Advant OCS process stations or computers (RCOM).

RCOM/RCOM+ works with the master-slave principle. The communication is performed via point-to-point or multi-drop connection. You can also connect a dialing modem on telecommunication authority lines. The modem must have command-initialized dialing and an automatic reply function.

You can find detailed technical information about RCOM for Advant Controller 110 in following document:

- RCOM: Function description, installation, configuration, maintenance and technical data: *RCOM Advant Controller 100 Series, User's Guide.*

You can install RCOM or RCOM+ in Advant Controller 160 using the MultiVendor Interface (MVI) CI532V01 and Advant Controller 160 OPT2 SW.

NOTE

The submodule carrier SC610 and consequently RCOM/RCOM+ is not supported by dual redundant Processor Modules PM645/PM646 (CPU redundancy).

It requires one Processor Module PM640, PM644, PM645, or PM646 or one Processor Module PM645A/B or PM646 within station redundancy scheme.

3.1.5.7 Siemens 3964(R)

Outline description

MultiVendor Interface (MVI) is used to communicate with other manufacturers' control systems. The Siemens 3964(R) protocol is available as standard.

MVI (CI532) uses a V24/RS 232C asynchronous serial communication link. This link allows communication at long distances via modem.

Siemens 3964(R) in Advant Controller 160 is called MVI-Siemens 3964(R) and is used for communication with, for example, other manufacturers' control systems (PLCs).

You can only use MVI-Siemens 3964(R) in point-to-point type connections. MVI-Siemens 3964(R) is available for the Siemens 3964 (no checksum) and the Siemens 3964R (with checksum) protocols. The link can operate in quasi-full-duplex mode, that is, both Advant Controller 160 and the PLC can take initiative to start a data transfer. The transmission speed is up to 19200 bits/s.

You can find detailed technical information about Siemens 3964(R) in Advant Controller 160 in following document:

- MVI – Siemens: Function description, installation, configuration, maintenance and technical data:
  MVI – Siemens Advant Controller 100 Series, User's Guide

NOTE

The submodule carrier SC610 and consequently Siemens 3964(R) is not supported by dual redundant Processor Modules PM645/PM646 (CPU redundancy).

It requires one Processor Module PM640, PM644, PM645 or PM646 or one Processor Module PM645A/B or PM646 within station redundancy scheme.

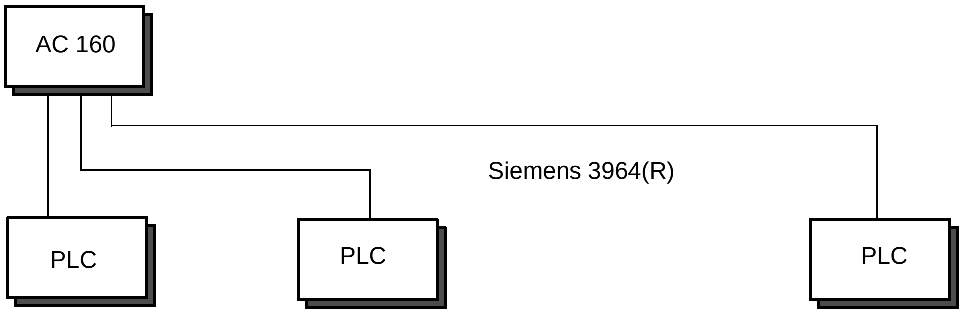


Figure 3-18. Example of an MVI-Siemens 3964(R) Configuration

3.1.5.8 MODBUS

Outline Description

The **Gould Electronics protocol** MODBUS is available as standard. You can use it for communication with, for example, other manufacturers' control systems (PLCs). You can install MODBUS in Advant Controller 160 in two ways:

- using MODBUS I driver on the second serial interface of Advant Controller 160 Processor Module and OPT4 software.
  Only slave function is supported in this case. That means Advant Controller 160 is MODBUS slave with a fixed slave number 1. See Section 3.1.7.1, Local Operator Station for calculation of MODBUS data address.
- using the MultiVendor Interface (MVI) CI532V02 and OPT2 software.

MultiVendor Interface (MVI) is used to communicate with other manufacturers' control systems. MODBUS in Advant Controller 160 using MVI is called MVI-MODBUS.

MVI (CI532) uses a V24/RS 232C asynchronous serial communication link. This link allows communication at long distances.

You can use MVI-MODBUS in point-to-point or multidrop type connections. Advant Controller 160 acts as a master or slave station. MVI-MODBUS is available in RTU (binary) and ASCII mode. The transmission speed is up to 19,200 bits/s.

Traffic on the MVI-MODBUS link is controlled by the master station. Direct communication is only possible between the master and the slaves.

You can find detailed technical information about MODBUS in Advant Controller 160 in following documents:

- MVI – MODBUS: Function description, installation, configuration, maintenance and technical data:
  MVI – MODBUS Advant Controller 100 Series, User's Guide.
- Description of how to connect a panel to Advant Controller 160 using the MODBUS protocol:
  MODBUS Panel Connections Advant Controller 100 Series User's Guide.

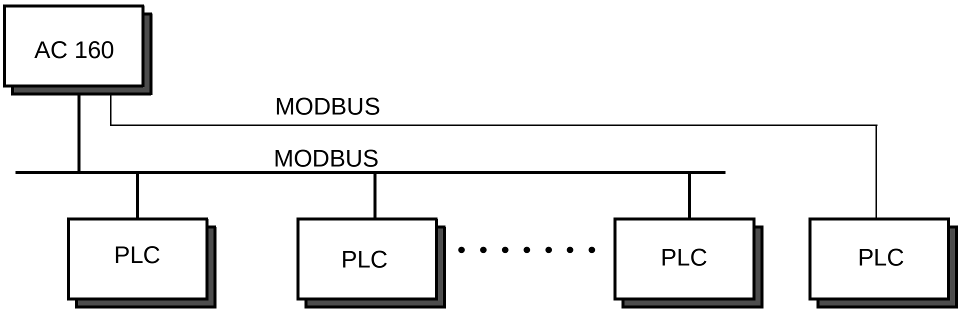


Figure 3-19. Example of an MVI-MODBUS Configuration

Guidelines

- MODBUS using second serial interface at PM640, PM644, PM645, or PM646. This is only possible if just one MODBUS channel is required. This solution is inexpensive since no MultiVendor Interface (MVI) CI532 is needed for MODBUS.

NOTE

With the DB element MODCHAN the node (slave) address of the MODBUS interface can be configured. If the MODCHAN DB element is not created in the application, the fixed node address "1" will be used. See Section 3.1.7.1, Local Operator Station for details.

- MODBUS using submodule CI532V02 + submodule carrier SC610
- This solution should be chosen if MODBUS master function is needed or several MODBUS channels are required.

NOTE

The submodule carrier SC610 and consequently MODBUS is not supported by dual redundant Processor Modules PM645/PM646 (CPU redundancy).

It requires one Processor Module PM640, PM644, PM645 or PM646 or one Processor Module PM645A/B or PM646 within station redundancy scheme.

3.1.5.9 PROFIBUS-DP

Outline Description

- PROFIBUS-DP is a fieldbus intended to connect Advant Controller 160 with Distributed Peripheral Modules (slaves).

  Advant Controller 160 acts as a master on PROFIBUS-DP and controls the dataflow on the bus.

  You need the Processor Module PM644 to utilize PROFIBUS-DP. It provides one PROFIBUS-DP master interface that conforms with standard EN 50170.

  Up to 6 Processor Modules PM644 can be used in an Advant Controller 160.

PM644 supports communication speeds from 9600 Baud up to 12 MBaud on PROFIBUS-DP.

- You can find detailed technical information about PROFIBUS-DP in Advant Controller 160 in the following documents:
  - *PROFIBUS-DP Advant Controller 110/160 User's Guide*
  - *PROFIBUS Library Editor User's Guide*

Up to 126 devices (master or slaves) are connected in a bus structure (i.e., line). For load reasons this bus is divided into so-called segments. Up to 32 devices can be connected in one segment. The bus is terminated by an active bus terminator at the beginning and end of each segment.

To ensure error-free operation, both bus terminations must always be powered. Many vendors have designed a switchable bus termination in their devices or plug connectors. When more than 32 devices are used, repeaters (line amplifiers) must be used to connect the individual bus segments.

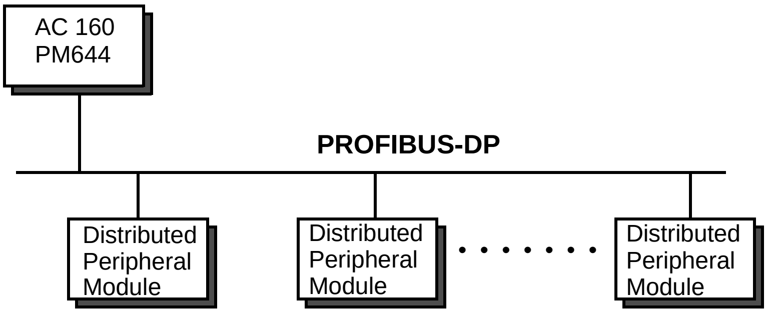

AC 160
PM644
PROFIBUS-DP
Distributed Peripheral Module
Distributed Peripheral Module
Distributed Peripheral Module

Figure 3-20. Example of an PROFIBUS-DP Configuration

The maximum distances that can be covered with PROFIBUS-DP depend on the used baudrate. Table 3-4 shows the maximum distances.

Table 3-4. Distances based on transmission speed.

Baud rate (Kbit/sec)	9.6	19.2	93.75	187.5	500	1500	3000	6000	12000
Segment length (m)	1200	1200	1200	1000	400	200	100	100	100

3.1.6 Process Control

General

Advant Controller 160 offers powerful features covering all aspects of process control in most application areas. For information on the application language the principles of configuration and application building and the functional resources used, see the following sections.

Appropriate Hardware and Software

See Section 1.8, Product Overview for the available general function block library included in the basic system program and different additional software options. You are also referred to information regarding necessary hardware and software given in other sections in this chapter. These sections are more focused on concrete functions.

Interface to Application Program

The controller data base is the normal interface to the application program. For example, there are different data base elements representing process interfaces such as Analog Input, Digital Output, and so on. See Section Section 3.1.6.2, Principles of Application Building for more information.

3.1.6.1 Application Language

Process control applications are programmed in the ABB Master Programming Language (AMPL), a function-block language with graphic representation which has been developed especially for process control applications.

You can program a controller in AMPL fully on-line, that is, with the programs running and controlling the process. If required, you can block part of a PC program, a complete PC program or the whole controller during programming. You can also develop programs off-line in an Engineering Station and load them into the controller at a later stage.

In addition to functional PC elements, AMPL contains a number of structural elements for division of a PC program into suitable modules which can be managed and executed individually. You can give the modules different cycle times and priorities so that both fast and slow control operations can be managed by the same PC program.

The inputs and outputs of a PC element are connected to the inputs and outputs of other elements or to process I/O points. Picking these elements and making these connections constitutes the programming work. The resulting PC program can then be documented graphically, as the figure below illustrates.

Signals can be represented in engineering units throughout the whole application program. This can facilitate the configuration work, especially in combination with arithmetic operations. It also can simplify reading and understanding of the graphical documentation of the application program. Scaling of an I/O signal from an electrical variable, for example, 4 – 20 mA, to a variable expressed in engineering units is made in the data base.

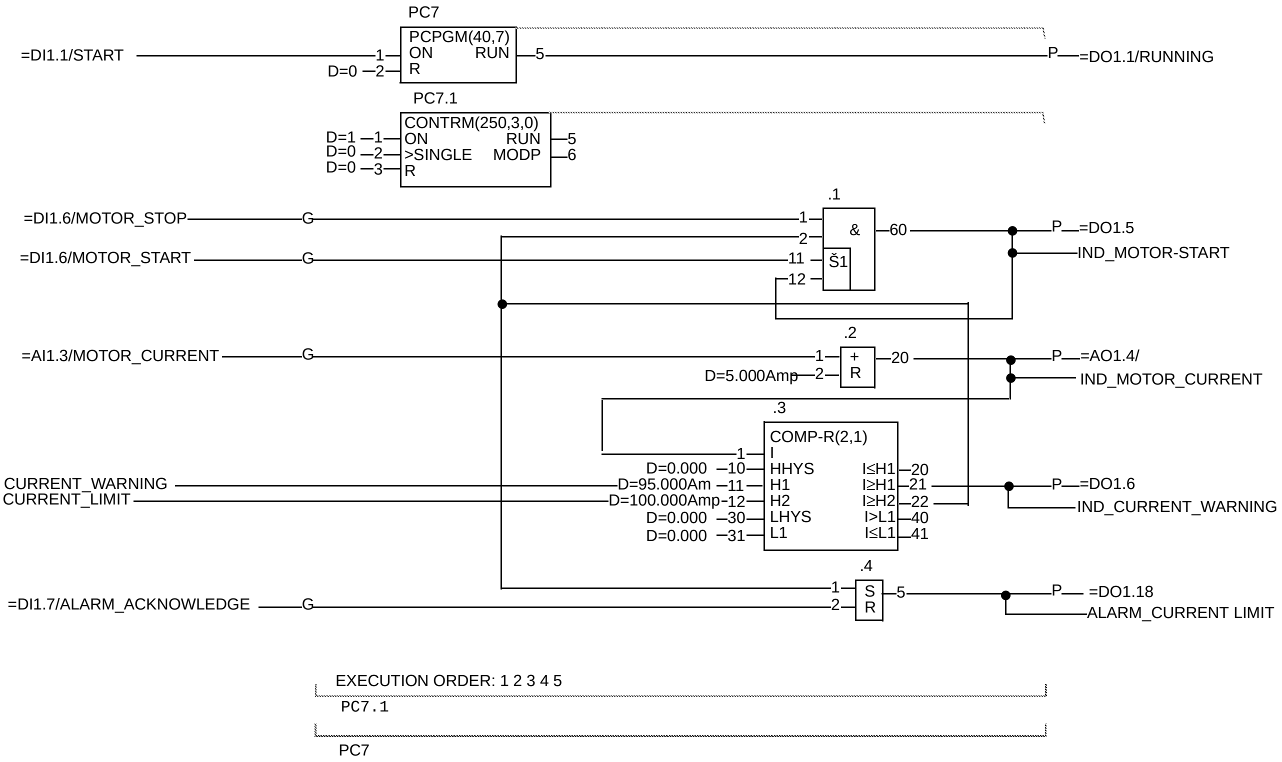


Figure 3-21. Example of PC Diagram of an AMPL Program

To boost application programming productivity even further, the Engineering Stations support the use of standard solutions to control problems that are repeated frequently in an application area or in a specific application project. For instance, a standard solution may comprise all the functions required to control motors of a certain type, or pumps, valves, temperature loops, and so on.

For information about AMPL, see *AMPL Configuration Advant Controller 100 Series, Reference Manual.*

3.1.6.2 Principles of Application Building

Overview

Figure 3-22 illustrates how process signals available in the data base are linked to the AMPL application program.

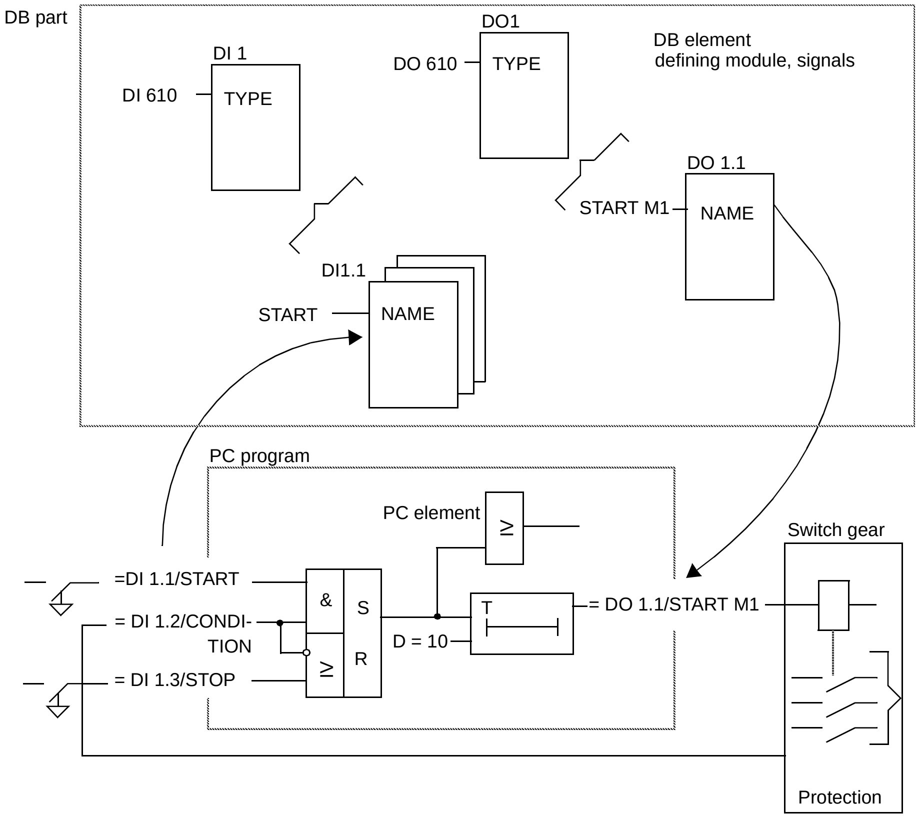


Figure 3-22. Simple Control Function Realized in AMPL

The user application program is the software you produce using predefined functions in Advant Controller 160.

The user application program for Advant Controller 160 consists of:

- DB elements of the related target, the configuration part
- PC elements of the related PC program, the program part.

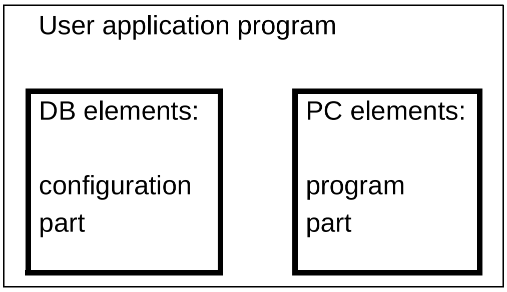


Figure 3-23. User Application Program for Advant Controller 160

Generation and Storage

You can generate and store a user application program for the Advant Controller 160 system in the Engineering Station.

The common way to create or modify a user application program for an Advant Controller 160 system is to use Function Chart Builder (FCB) in Advant Station 100 Series Engineering Station.

After you have generated a user application program, the target code representation of this application must be generated and then downloaded to Advant Controller 160.

Configuration

An Advant Controller 160 consists of one or more Processor Modules, a power supply and modules for process I/O and/or Communication Interfaces (see Figure 3-24).

The configuration part of a user application program contains the configuration elements of an Advant Controller 160 system:

- Hardware description
- Common data description
- Data exchange description.

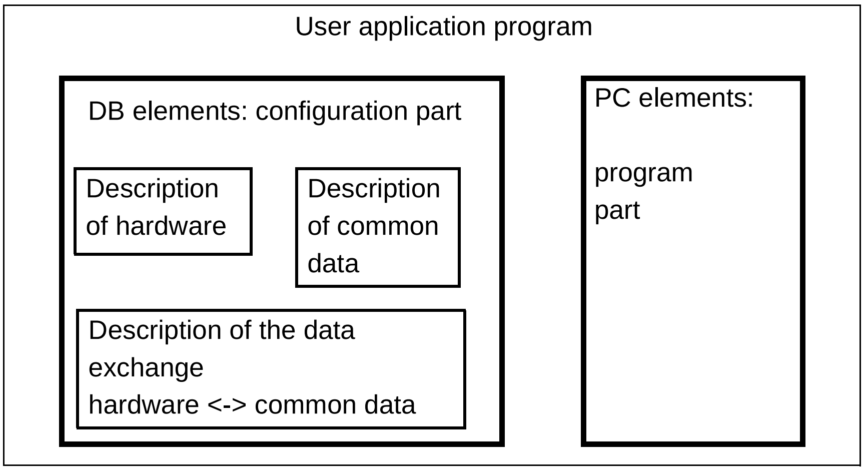

User application program
DB elements: configuration part
Description of hardware
Description of common data
Description of the data exchange hardware <-> common data
PC elements: program part

Figure 3-24. Configuration Part Within the User Application Program

Configuration, DB Elements

DB elements in an Advant Controller 160 system describe

- the hardware of Advant Controller 160
  - Processor Modules
  - process I/O.
- Communication Interfaces
  - backplane I/O bus extension
  - connection to AF 100
  - MVI.
- the common data elements
  - DAT, PARDAT
- the connection between the hardware and the common data elements
  - DataSet Peripheral (DSP).
- event handling.

The DB elements are described in the manual *Data Base Elements Advant Controller 160 Reference Manual.*

PC Program

The program part of a user application program describes the control algorithm and the control strategy. It contains the required PC elements, their interconnections and the connections to the DB elements.

This part of an Advant Controller 160 user application program is called the PC program. It consists of the PCPGM header element and subordinated structure and basic PC elements.

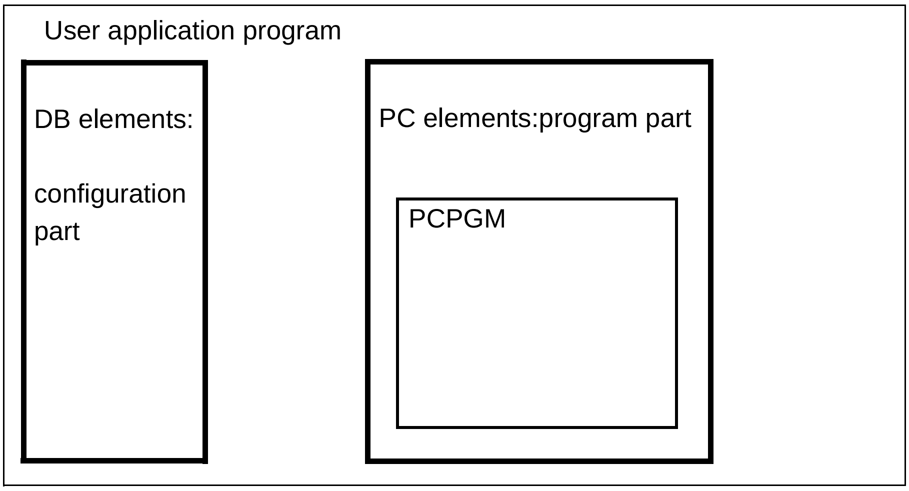


Figure 3-25. Program Part Within the User Application Program

PC Program, PC Elements in general

The fundamental unit of the PC part is the PC element:

• Basic element	The implementation of a complete function (for example, a counter element, a delay element, …)
• Structure element	An element for structuring and execution control of the PC program, for example an executable unit.

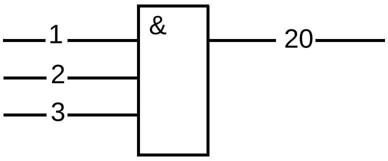


Figure 3-26. Example of a PC Element in Graphical Representation

PC elements may have input and output terminals to interconnect them and to connect them to DB elements or constants. Each element is represented in a PC diagram by a graphic symbol designed to describe the function of the element.

PC Program, PC Diagram

The PC diagram is the usual representation of a PC program. The PC diagram is a graphical representation of the PC elements and their interconnections.

For creation and modification of PC elements and their interconnections, the Engineering Stations contain an editor in PC diagram representation (function chart representation).

For documentation, PC diagrams can be generated by the Engineering Station.

PC Program, Executable Unit

A PCPGM on an Advant Controller 160 system is divided into executable units. Every executable unit acts with its own scheduling parameters, for example, with its own cycle time.

In Advant Controller 160 the following executable units exist: CONTRM, MASTER, SEQ and the PCPGM. Note that SEQ cannot be used for redundant processing, see Note within Section 3.1.6.3, Control Functions.

3.1.6.3 Control Functions

The main control functions built-in which are available for application building are grouped and presented briefly below. Most of the functions are supported by PC elements, that is, the PC elements are the base of the functionality of Advant Controller 160. For a listing of those PC elements included in the basic system program module and the different optional program modules, see Section 1.8.2.2, Functions of BASE System Software. For detailed function descriptions of the different PC elements, see the separate reference manual, *PC Elements Advant Controller 160 Reference Manual*.

Logic and Time Delays

- Basic Boolean functions
- Composite Boolean functions
- On/off delay, pulse generation.

Sequence Control

- General structuring functions
- Sequence control.

NOTE

The PC elements SEQ and STEP cannot be used with redundant processing. Instead the PC elements GRC and P_STEP must be used.

Calendar Time Functions

Date and time can be used when an automatic function shall be started or when a report is printed out.

Arithmetic

Standard arithmetic expressions as well as special functions are available.

Pulse Counting, Frequency Rotational Speed Measurement

These functions are used for different applications in Advant OCS, such as position measurement, flow measurement, speed measurement, synchronization of machine movements, and so on.

The pulse-counting function requires special hardware. You can use the pulse counter module DP620 and the rotational speed signal input module DP640. Additionally, the on-board speed inputs of the Processor Modules PM644, PM645B and PM645C can be used together with the PC element RSM (rotational speed measurement).

Supervision

Any logic state transition in the process or application program, or any limit transition of a process variable or calculated variable, can be defined as a point of event.

Events can be time-stamped with a resolution down to 1 ms, which enables you to perform excellent analyses of cause and effect in complex situations.

Measuring

You can connect process variables with different electrical representations as follows:

- Standard signal types, for example, 4 to 20 mA, 0 to 10 V, and so on
- Pt 100, Thermocouple
- Pulse, Frequency.

Pre-filtering is important in digital systems to obtain interference-free control and logging. The irrelevant frequency content in the process signals must be limited. Standard signals for current and voltage are pre-filtered in steep active hardware filters whereas temperature measurement signals are filtered by integrating A/D conversion. In addition to hardware filtration, the software can select digital filtration with single pole filters and with the required break frequency.

In the case of temperature measurement, linearization is performed in accordance with the type of PT 100 transducer or thermocouple selected.

Feedback Control

Powerful functions for feedback control are provided with a great number of PC elements within **OPT1**. Examples of these PC elements are:

- P-1, **P**roportional regulator
- INT, **Int**egrator
- DER, **Der**ivator
- PI, **P**roportional **I**ntegrating regulator
- PID, **P**roportional **I**ntegrating **D**erivative regulator
- PIP, **P**roportional **I**ntegrating **P**roportional regulator
- PDP, **P**roportional **D**erivative **P**roportional regulator
- CON-PU1, **Con**troller - **Pu**lsed **1**
- RAMP, **Ramp** generator.

3.1.6.4 Guidelines for Application Building

This section is a collection of suggestions and ideas for program design and structuring. The following are general rules for program design:

- Structure the application program (see below).
- Write programs that are as easily understandable as possible.
- Avoid “smart” programming unless absolutely necessary to achieve the necessary performance.
- Prepare a draft PC diagram in which the required function is built up with the help of PC elements.
- Use the largest elements possible.
- Use the most powerful elements possible.
- Use the principles of typical solutions (Type Circuits).

Structuring of the Application Program

When structuring the application program, you must satisfy these three requirements:

- Structuring in accordance with the structure of the plant and the process.
- Structuring in accordance with execution time.

The structure elements primarily used are PCPGM, CONTRM and FUNCM. SEQ and STEP can be used with sequential control but only for non redundant processing, see paragraph Sequence Control.

The elements PCPGM, CONTRM and SEQ control the execution. You can activate and deactivate these elements from outside—do this when high performance is required. The elements are only activated when execution of the subsidiary program (-section) is necessary.

Place the activation and deactivation for the execution control in a software module with a short cycle time. Note, however, that there may be occasions such as at start, stop and emergencies when you must run all programs (-parts) simultaneously. If there are such occasions, they determine how hard the controller can be utilized.

Use the following rules when structuring:

- Do not place the whole application in just one executable unit.
- It is preferable that you place independent parts of the application program which have no data exchange or a limited data exchange in different control modules.
- A control module (CONTRM) delimits a function to which a special cycle time is applied.
- A function module (FUNCM) delimits a function within a control module (CONTRM) and divides a control module into sub functions. Start each function with a FUNCM.
- Do not use nest function modules (FUNCM).
- Do not use executable units under a FUNCM.
- Do not use more than three levels with structure elements except in special cases.

- Use BLOCK elements to close part of a control module CONTRM when reducing the load on Processor Module.

NOTE

Writing to the data base continues while the blocking is active.

Use a simple pin diagram when you are structuring the application program.

Sequence Control

Two methods and sets of PC elements are available for the configuration of sequence control (see Table 3-5).

Table 3-5. Configuration of Sequence Control

Set of PC elements	Executable Unit	Usable for redundant processing
SEQ + STEP	SEQ	No
GRC + P_STEP	CONTRM	Yes

3.1.7 Operator Interface

3.1.7.1 Local Operator Station

Appropriate Hardware and Software

Communication with a local operator station is an application of MODBUS. See Section 3.1.5, Communication.

You can connect panels or a PC-based Operator Station directly with cable via RS 232C serial interface at connector **Com B** on the front plate of the Processor Module.

No additional Communication Interface module is necessary.

You need software option OPT4 which provides Modbus protocol on the second serial interface of PM640, PM644, PM645, or PM646 module.

NOTE

In case of redundancy both master and slave Processor Module send and receive via its own Modbus interfaces.

Physical Connection

You can use following serial interface for connection with local operator station, HMI or panel:

- Connector:
  - Connector **Com B** (RS 232C) on the front plate of the Processor Module

- The LINE characteristics:
  - 9600 baud rate
  - 1 start-bit, 1 stop-bit
  - no parity.

To establish the RS 232C connection between the local operator station and Advant Controller 160, just plug the connection cable into the RS 232C connector of the PC-based operator station and connector **Com B** on the front of PM640, PM644, PM645, or PM646 module.

Communication with Local Operator Station

The local operator station communicates with Advant Controller 160 via the MODBUS protocol (binary). With Advant Controller 160, it can only be used as a point-to-point network (because of the RS 232C). The master of this communication link is on the operator station side, Advant Controller 160 is the slave.

1. The (slave) address of Advant Controller 160 can set in DB element MODCHAN. For older version of the BASE software which do not make use of the MODCHAN DB element the address is fixed to 1.
2. Only the **function codes** 1 – 8, 15 and 16 are implemented, see Table 3-8.
3. There is no way to access outputs or inputs directly. Advant Controller 160 can only read or write to global memory via data base elements. The following **data base elements** can be used:

Table 3-6. Data Base Elements for MODBUS

Call name	Function	Size in Bytes
PARDAT(I)	Stores one integer value.	2
PARDAT(IL)	Stores one long integer value.	4
PARDAT(B)	Stores 32 boolean values.	4
PARDAT(NB)	Stores 32 named boolean values.	4
PARDAT(R)	Stores one real value.	4
PARDAT(II)	Stores two integer values.	2×2
PARDAT(NI)	Stores one named integer value.	2

4. MODBUS only defines the **data types** „bit“and „word“. So in Advant Controller the transmission of boolean and integer values is possible. Because the values for long integer and for real are stored in two words (4 bytes), you must use MODBUS function codes for multiple access on words it to read or write these data types. If the panel can cascade two words as low and high, long integer value access may be realized. Access to real values could also be realized, if the configuration software of the panel is able to handle the IEEE single precision format, or is able to transform it (for example with an internal program language).

5. **The communication settings for MODBUS driver on Advant Controller are:**

Table 3-7. Communication Settings for MODBUS

Baud Rate	9600
Start Bit	1
Stop Bit	1
Parity	NONE
Error Checking	CRC(1)

(1) Cyclical Redundancy Check

6. The MODBUS **address calculation**:
All signals of an application on Advant Controller to be accessed via MODBUS must be represented by a PARDAT data base element. As mentioned above, it is only possible to read or write to and from memory, direct access to input or output is not supported.

Bit address: ADDR = (n × 32) – k

Integer address: ADDR = (n – 1) × 2 + m

ADDR = MODBUS address.

n = item designation of the PARDAT data base element (example: n = 3 for PD3).

k = bit offset in the PARDAT(B) element, starting with 0 (example: m = 8 for bit number 9 in a PARDAT(B)).

m = the offset in the PARDAT(II) element, starting with 0
(example: m = 1 for value number 2 in a PARDAT (II)).

Advant Controller 160 does not distinguish between the small and the large MODBUS models. The ADDR in the MODBUS telegram is actually an offset in a local data area on the controller, i.e. for PD1 and PD3 being PARDAT(B) and PD127 being PARDAT(I) you would have to specify the following addresses in the MODBUS telegram:

1 × 32 – 0 = 32 to read PD1:VALUE

3 × 32 – 2 = 94 to read PD3:VALUE3

(127 – 1) × 2 = 252 to get the integer value of PD127.

On the MODBUS Master side the address for PD127 may be specified as (H'40000 + 252) or (H'4000+252), but this address does not show up in the MODBUS telegram. The distinction between BIT and INTEGER access is done by the function code.

Communication Protocol

The communication protocol for data exchange between Advant Controller 160 and local Operator Station/HMI is the standardized MODBUS protocol. The following MODBUS functions are supported:

Table 3-8. MODBUS Functions

Func. Code	MODBUS Function	Data Access in Advant Controller 160
01	Read coil status	One bit in a PARDAT(B)
02	Read input status	One bit in a PARDAT(B)
03	Read holding register	One word in a PARDAT(I), PARDAT(II), PARDAT(IL) or PARDAT(R)
04	Read input register	One word in a PARDAT(I), PARDAT(II), PARDAT(IL) or PARDAT(R)
05	Force single coil	One bit in a PARDAT(B)
06	Force single register	One word in a PARDAT(I), PARDAT(II), PARDAT(IL) or PARDAT(R)
07	Read exception status	Get Advant Controller 160 status
08	Read diagnostic counter	Get internal counters on Advant Controller 160
15	Force multiple coils	Bits in a PARDAT(B)
16	Force multiple registers	A number of word in a PARDAT(I), PARDAT(II), PARDAT(IL) or PARDAT(R)

The function codes 1 and 2, as well as 3 and 4, work identically when reading from the internal memory. The function codes 1, 2, 3, 4, 7 and 8 are not allowed for broadcasting when Advant Controller 160 is configured as slave.

3.1.7.2 Central Operator Station

Appropriate Hardware and Software

Communication with a central operator station, AdvaSoft for Windows, is possible via Advant Fieldbus 100 or RCOM+. See Section 3.1.5, Communication.

To support AdvaSoft for Windows you need Advant Controller 160 software option OPT3 which provides event handling. In addition if you communicate via RCOM+ you need option OPT2 for RCOM+ using MVI.

Beside Advant Controller 160 software option OPT3 which provides event handling you need no additional software options to support AdvaSoft for Windows.

NOTE

OPT2 and OPT3 are both included within the BASE system software.

The operator station products are described separately.
For information about AdvaSoft for Windows, see *AdvaSoft 2.0 for Windows NT, User’s Guide.*
For information about Advant Fieldbus 100, see *Advant Fieldbus 100 User’s Guide*.
For information about RCOM/RCOM+, see *RCOM Advant Controller 100 Series User’s Guide*.

3.1.8 Heat Dissipation

3.1.8.1 Cabinet Ventilation

To avoid overheating, when ambient temperatures are high, take into consideration the heat dissipated in the electronics cabinet. This is particularly important with sealed cabinets (IP54) or tropicalized cabinets (IP41) with considerable circuit board equipment and ambient temperatures at levels approaching 40 °C.

It is, therefore, important to maintain as low a temperature as possible where the equipment is installed.

The different hardware modules in the controller and the I/O system have different outputs of heat. Accurate calculation of the heat produced by the system requires knowledge of the modules and the work cycle.

3.1.8.2 Heat Dissipation Permitted in Cabinets

The permissible amount of heat generated depends on the type of cabinet and its location. Table 3-9 indicates the heat generated to give a 15 °C temperature rise and a 30 °C temperature rise in the cabinets.

Please note that there is normally no requirements for fans in an Advant Controller 160.

The standard design and assembly of cabinets aim to give a maximum of 15 °C temperature rise within the cabinet, which results in a maximum permitted ambient temperature of 40 °C.

In critical applications with subracks fully equipped and cabinets arranged in groups, you may need to make a calculation of the actual power dissipation and an estimation of the temperature rise within the cabinet. Calculation is recommended at system enlargement too.

Some data to be used in calculations is given below. You can find information about power dissipation for different hardware modules in *S600 I/O Hardware Reference Manual* and *S600 I/O Hardware Advant Controller 160 Reference Manual*. Cabinets including a single subrack normally have no temperature rise higher than 15 °C, irrespective of the disposition of the subrack, cabinet type and location of the cabinet.

Table 3-9. Max Permitted Power Dissipation, RM5yy Cabinet

Cabinet type	**Permitted Power dissipation**	
	15 °C rise	**30 °C rise**
Ventilated cabinet:		
– Without fan	450 W	900 W
– Fan	750 W	1500 W
Sealed cabinet:		
– Without fan	180 W	360 W
– Fan	340 W	760 W
– Heat exchanger (air to air)	500 W	1000 W

3.1.8.3 Cabinets in Groups

When cabinets are installed in groups, reduce the permitted power dissipation in accordance with Figure 3-27. The permitted power dissipation in a particular cabinet is the power specified in Table 3-9 (and Table 3-9) multiplied by a factor from Figure 3-27.

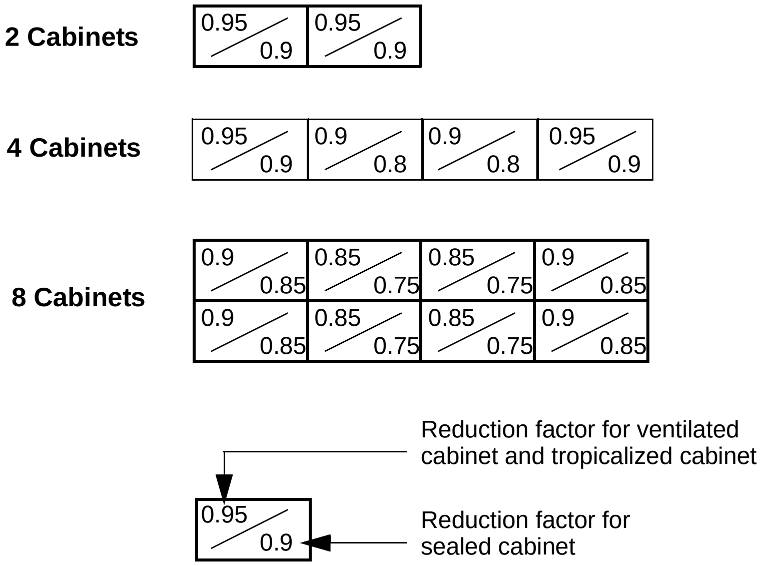


Figure 3-27. Reduction Factors for Cabinets Installed in Groups

3.1.8.4 Calculation of Heat Generated in a Cabinet

When you are calculating the heat generated in a cabinet, add up the heat generated by the different hardware modules. To this sum, add the heat generated by the power supply units and other equipment such as an extra modem, extra unit for supply of power to transmitters, and so on.

See *S600 I/O Hardware Reference Manual* and *S600 I/O Hardware Advant Controller 160 Reference Manual* for current consumption and for the power dissipated.

A power supply unit located beneath the subracks contributes to the total power dissipation with 100 W. Do not include redundant power supply units in the calculation of number of units because of the load shedding.

The total power dissipated in the cabinet can be written as follows:

$$P_{Total} = \sum P_{C-module} + \sum P_{IO-module} + \sum P_{Voltage\text{–}supply\text{–}unit} + \sum P_{Sundry}$$

3.1.9 Module Types and Programming Style

From a maintenance viewpoint, use as few module types as possible in the hardware disposition of a control system. This is most relevant with the process I/O design. Standardization of I/O signal types and other electrical qualities is important to minimize the spare part stock.

If possible, do not use “smart programming” when you make an application program. Your solutions must make sense to the maintenance people in the event of disturbances and following trouble-shooting.

3.1.10 Expansion Possibilities and Spare Considerations

Expansion Possibilities

You can connect a new Advant Controller 160 to an existing Advant Fieldbus 100 control network. The new controller is automatically incorporated in the communication system.

You can expand the controller step by step, that is, the system can be enlarged and made more complex in different ways. Examples of such areas are:

- Process I/O.
- Processing power through multiprocessing.
- Communication with external computers and other systems.
- Operator functions.
- Application program.
- Redundancy.

Of course, there are some limitations such as maximum number of possible instances and functionality offered by the available library. You can install additional software options if certain optional functions are required. For limitations, see Section 3.2, Capacity and Performance.

If required, you can carry out most expansions and operations on-line. You can expand your application program with additional PC or DB elements on-line. No extra preparation like dimensioning an number of spare instances in the data base or spare PC program structures is necessary. You need just enough memory in the Processor Module for the complete application program. Extensive reconfiguration and enlargement of the system is normally linked to revamping the plant. Shut-down of the system and off-line work is then advisable.

Spare Considerations

In addition to what is said above regarding memory for additional application programs, there is a simple rule of thumb for hardware design:

You can add new I/O modules on-line. It is practical to keep approximately 10 – 20% of the channels spare. The same recommendation is valid for spare space in subracks.

3.1.11 Availability and Safety

Many factors affect the reliability and availability of a control system. Redundancy is perhaps the first thing to reflect upon, but it is never the most important factor. Basic system properties of Advant OCS are, in general, more important. Advant OCS is designed to satisfy extreme demands for reliability, availability and safety. For further discussion of various aspects of reliability, availability and safety, see the following keywords:

- Solid mechanical and electrical construction
- Security against electrical interference
- High-quality components

- Well-tested electronic units
- Thoroughly developed and tested modular software
- Easily interpreted program language for application programs, AMPL
- Complete documentation
- Integral supervision and diagnostic functions
- Powerful tools for testing
- On-line replacement of faulty hardware units
- After-sale service
- Redundancy.

For descriptions of the provided diagnostics please see Section 5.4.2, Diagnostics. The behavior of process outputs is described in Section 3.1.11.1, Process Outputs Behavior at Interruptions.

Below you can find information regarding safety and the possibilities of redundancy in Advant Controller 160.

3.1.11.1 Process Outputs Behavior at Interruptions

From the viewpoint of safety, the behavior of the control outputs to the process in connection to ordered or unintentional interrupts and faults is very important. Advant OCS has a straightforward philosophy: all process outputs are to be controlled to zero and relay outputs are to be deenergized.

NOTE

- The behavior of the S600 module outputs depends on the configuration of the controller. Output set to predetermined must be configured.
- There is no automatic output set as predetermined position. Instead, the output set as predetermined position can be configured with use of the relay outputs of the Processor Modules which are switched over in case of a severe error (see Section 3.1.2.2, Run/Alarm Relay). Both an open and a closed contact are provided per Processor Module. For example the relay outputs can be used to switch off the external voltage for digital outputs if the Processor Module which controls theses outputs fails.

Unintentional interrupts are caused, for example, by the following events:

- Fault in central processing unit and memory
- Loss of power supply
- Fault in power supply
- Fault in parallel bus communication (backplane bus).

3.1.11.2 Redundancy

Advant Controller 160 supports redundancy for all central functions and modules:

- Mains distribution network
- Voltage supply (24 V input and distribution, redundant power supply modules SA610)
- Advant Fieldbus 100 (cable redundancy, redundant Communication Interface CI630)
- Redundant Processor Modules PM645A, PM645B, or PM646 (CPU redundancy). See Section 3.1.11.3, Redundant Processing with Internal Voting.
- I/O expansion (redundant I/O expansion bus, redundant extender modules CI615 and CI610)
- Redundant Advant Controller 160 (1 out of 2 and 2 out of 3 station redundancy). See Section 3.1.11.3, Redundant Processing with Internal Voting.

You can add redundancy in a flexible way to meet the desired demands upon system reliability.

The controller utilizes different principles of redundancy for included subsystems. Both hot stand-by and independent parallel operation are used. Also, a combination of hot standby and parallel operation is possible. Duplicated hardware is primarily used in what is known as 1:1 implementation or 1 out of 2 configuration. But also 2 out of 3 configuration is possible.

Maintainability is always provided by diagnostics, fault announcement and adequate unit exchangeability with hot-replacement facility.

Mains Distribution Network

Redundant a.c. networks, or a combination of an a.c. network and a d.c. network, are primarily connected to separate circuit breakers and power supply units. Secondarily, at 24 V level, the two networks are wired by diodes. The controller always needs an a.c. supply for use by certain external equipment such as modems, and so on. In the case of redundant a.c. networks, automatic relay devices are used to maintain the power supply in case of a single network error. The duplicated equipment is normally in parallel operation, sharing the load. In the event of a single failure, the full load is taken over bumpless by one piece of equipment.

Power Supply, 24 V

Duplicated power supply units, decoupled wired by diodes, are utilized for 24 V d.c. This is the same redundancy solution as for the mains distribution network.

The power supply modules SA610 for feed with 230 V a.c. can be configured according to a n+1 strategy for n ≤ 3. Up to four modules can be installed per station (basic or I/O station). If one module fails the other one to respectively three modules can provide the needed power.

Advant Fieldbus 100

Transmission media redundancy is possible. Two Communication Interfaces CI630 or CI631 can be used as redundant interface to the main or subordinate Advant Fieldbus 100.

3.1.11.3 Redundant Processing with Internal Voting

Advant Controller 160 supports redundant processing with system integrated internal voting:

- Redundant Processor Modules PM645A, PM645B, or PM646 (CPU redundancy)

- Redundant Advant Controller 160 (1 out of 2 and 2 out of 3 station redundancy).

Restrictions and Rules

The PC elements SEQ and STEP cannot be used with redundant processing. Instead the PC elements GRC and P_STEP must be used.

All commands for process operation must be stored as historical values within the Processor Modules in order to allow synchronization of the redundant Processor Modules because synchronization uses the historical values of the master for tracking of the slave.

Therefore the PC element MOVERED can be used for all the data types Boolean, Integer (16 Bits), Integer Long (32 Bits) and Real.

CPU Redundancy with Processor Modules PM645A/B and PM646

Each, PM645A, PM645B and PM646 support CPU redundancy according to a 1 out of 2 scheme. The redundancy type can be configured within the application program via the Processor Module's DB element.

The CPU redundancy can be used if single point of failure of the Processor Module must not disrupt the application program. The loss of a single I/O module can be accepted in most power plant applications. This type of redundancy is used for all applications as a standard solution.

NOTE

> For CPU redundancy, Processor Modules PM645 or PM646 and redundant Communication Interfaces CI630 or CI631 must be used in order to avoid single point of failure even if no Advant Fieldbus 100 communication is required.

The 1 out of 2 CPU redundancy has the following features:

- Two Processor Modules within one station and with common I/O modules.
- Master slave hot standby principle:
  The master Processor Module controls the process via the output modules, the slave runs in parallel and balances its historical values continuously to those of the master. This continuous tracking prevents diverging of calculation results of the redundant Processor Modules. This feature guarantees bumpless switchover in case of a failure of the master.

If the master fails the slave Processor Module becomes master. The new master controls the process via the output modules. The switchover is done automatically within 10 ms. No external switches are necessary.

NOTE

> For CPU redundancy with common I/O modules the use of the PC element PC_AX646 is not allowed because this PC element is executing tests on corresponding input module alternating with the measured-value acquisition and therefore a redundant Processor Module would disturb this sequence.

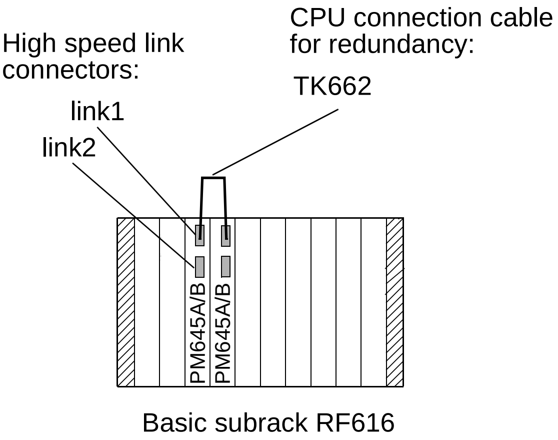

CPU connection cable for redundancy:
TK662
High speed link connectors:
link1
link2
PM645A/B
PM645A/B
Basic subrack RF616

Figure 3-28. Dual Redundant Processor Module within One Advant Controller 160

1 out of 2 Station Redundancy with PM645A/B and PM646

PM645A/B and PM646 both support 1 out of 2 station redundancy. The redundancy type can be configured within the application program via the Processor Module's DB element PM645 or PM646.

The 1 out of 2 station redundancy can be used if single point of failures of the Processor Module must not disrupt the control tasks to run and also the loss of a single I/O module must be avoided. This type of redundancy can be used for all applications which can be realized with the Processor Modules.

The 1 out of 2 station redundancy has the following features:

- Two Processor Modules within separate stations each with its own set of I/O modules.
- master slave hot standby principle:
  The master station controls the process via its output modules, the slave station runs in parallel. In contrast to CPU redundancy also the slave station puts out its output signals via its output modules. But only the outputs of the master station are connected to the process via the additionally installed external switchover selectors. The Processor Module within the slave station balances its historical values continuously to those of the Processor Module within the master station. This continuous tracking prevents diverging of the redundant Processor Modules and guarantees bumpless switchover in case of a failure of the master station.
- If the master station fails—that is one of its modules fails—the slave station becomes master and the switchover selectors connect the new master to the process. The switchover is done automatically including the external switches within 10 ms.

2 out of 3 Station Redundancy with PM645A/B and PM646 for Closed-Loop

Control

PM645A/B and PM646 both support 2 out of 3 station redundancy. The redundancy type can be configured within the application program via the Processor Module's DB element PM645 or PM646.

For highest availability the 2 out of 3 station redundancy can be used. This type of redundancy is only applicable to modulating control including its associated binary control logic, for example as option for Turbine modulating control.

Typical possible applications are closed-loop control for steam and gas turbines.

The 2 out of 3 station redundancy has the following features.

- Three Processor Modules within separate stations each with its own set of I/O modules.
- Master slave work by principle:
  Work-by means that all three stations with its Processor Modules work in parallel, independent from one another. There is no continuous tracking. Each station performs the same application program and puts out its output signals via its output modules. But only one station, the leading master station, controls the process because only the outputs of the leading master station are connected to the process via the additionally installed external switchover selectors.
- If a station fails—that is one of its modules fails—the redundancy scheme automatically falls back to the 1 out of 2 mode. Then all features of the above described 1 out of 2 station redundancy are valid. This means that even two consecutive failures don't disrupt the control and I/O function of the 2 out of 3 redundant station.

  After repair the redundancy scheme automatically enters the 2 out of 3 mode again.
- In the 2 out of 3 mode the output signals of the three Processor Modules are supervised concerning possible deviations which may occur because of the asynchronous processing in parallel. In case of deviation the affected Processor Module balances its historical values once to those of the leading master. If the leading master is deviating, one of the other stations becomes leading master. Then the former master balances its historical values to those of the new leading master. This tracking on demand prevents diverging calculation results of the redundant Processor Modules. It guarantees bumpless switchover in case of a failure of the leading master station.

  The supervision of the three output signals is done within each station with the PC element TRAC. The threshold value for the detection of deviations with need for tracking must be configured.
- If the leading master station fails—that is one of its modules fails—one of the other stations becomes master and the switchover selectors connect the new master to the process. The switchover is done automatically including the external switches within 10 ms.

Each station performs self-diagnosis and additionally—in the 2 out of 3 mode—the output signals of the three Processor Modules are compared with one another according to a 2 out of 3 evaluation. Both methods together lead to a very high diagnostic coverage approximately 100 percent which means very high reliability and availability.

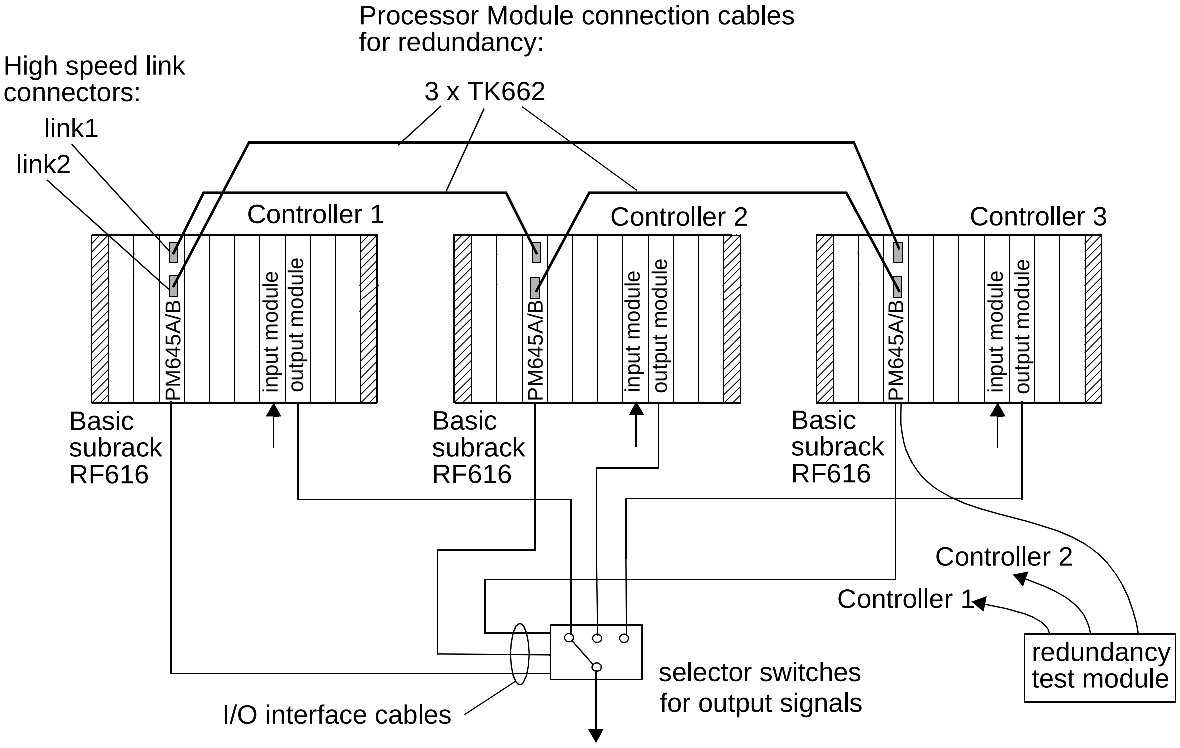


Figure 3-29. Triple Redundant Configuration with Three Advant Controllers 160

The 2 out of 3 supervision is done within each station with the PC element TRAC. The threshold value for the detection of inadmissible deviations must be configured.

Dependent on the specific configuration **additional HW modules and cables for redundancy** are needed:

- The redundant Processor Modules must be connected with one another via its high speed serial link interfaces. Therefore the cable set TK662 is to be used per connection.
- For configurations with redundant Processor Modules within different stations the output signals to be provided redundantly via separate output modules must be selected externally. Therefore selector switches for analog signals and for binary signals plus I/O interface cables must be used.

For commissioning of redundant configurations a Redundancy Test Module should be used. It can be used for CPU and station redundancy and is necessary for the commissioning of station redundancy.

Tracking

The Processor Modules within a redundant configuration must be synchronized in order to avoid diverging of the output signals. Diverging can be caused by differences in historical values of recursive processing functions. Recursive processing is realized by nature within several PC elements like integrator, flip-flop and so on, but also can be configured explicitly via feedback of a calculated value within the application program.

In order to keep diverging to a minimum, synchronization is done via tracking:

- continuous tracking of the standby Processor Module in case of 1 out of 2 redundancy
- tracking on demand of the work-by Processor Modules in case of 2 out of 3 redundancy.

During tracking the standby or the work-by Processor Module balances its historical values to those of the master Processor Module.

Two variants of tracking are available:

- unplanned tracking for 1 out of 2 CPU redundancy only
- planned tracking for 1 out of 2 CPU and station redundancy and for 2 out of 3 station redundancy.

In case of unplanned tracking the system software automatically uses the historical values of the configured PC elements and automatically establishes the links between the corresponding PC elements within the application programs of the master and the standby respectively work-by Processor Module. There is no need for additional planning if recursive structures with resulting historical values are avoided. Otherwise the special PC element MOVERED must be used in order to make the historical values accessible for the unplanned tracking.

For planned tracking the tracking values must be selected and its signal exchange via high speed link HSL must be planned within the application program using the DB elements HSLR (receive) and HSLS (send).

For 2 out of 3 station redundancy additionally the threshold value for the detection of relevant deviations with need for tracking must be planned. Therefore the PC element TRAC must be used. Additionally the PC element SW-RED must be used for automatic connection of the actual master's tracking values to the respective PC element inputs of the slaves.

In any case the tracking values are transmitted via the high speed serial links between the Processor Modules. The delay between generation of the tracking values within the master Processor Module and its consideration within the standby respectively work-by Processor Module is up to approximately one control task cycle.

For unplanned tracking historical values of up to 5 kByte per control task respectively 32 kByte per Processor Module can be transmitted. The maximum admitted number of historical values depends on the respective data types. For example a real value needs 4 bytes whereas an integer value needs 2 bytes only.

For planned tracking 128 tracking values of each data type can be transmitted, that is up to 128 boolean values + 128 integer values + 128 long integer values + 128 real values.

DB and PC elements for redundancy and tracking

- The Processor Module DB element (**PM645**, **PM646**) is to be used for configuration of

redundancy and tracking.
The station and slot addresses of the Processor Module are checked during initialization together with the position of the redundancy number selector switch (**CPU-Nr.**). If there are discrepancies, redundancy is considered to be defective and the Processor Module doesn't start the application.

The output TR_GRANT of the DB element PM645/PM646 is used for planned tracking. The output TR_GRANT automatically is set to logical 1, if the Processor Module is in tracking mode. This output is to be used to set the planned tracking values of the tracking slave to the respected values from the master.

- The DB elements **HSLS** and **HSLR** (High Speed Link Send/Receive) are used to configure the data transfer of the planned tracking values via HSL. The data type (Boolean, Integer, IntegerLong, Real) is specified at a terminal of the DB element.
- The PC element **MOVERED** is to be used for PC element configurations with internal feedback within redundant Processor Modules with unplanned tracking. MOVERED generates a historical value in addition to a simple move and makes the historical value accessible for unplanned tracking.
- The PC element **SW-RED** is only to be used for 2 out of 3 redundancy. One PC element SW-RED is needed for one planned tracking value each. SW-RED automatically selects the tracking value of the master.
- The PC element **TRAC** must be used for 2 out of 3 station redundancy for detection of deviations with a need for tracking and for the detection of inadmissible deviations. It also can be used for 1 out of 2 redundancy for supervision of deviations only without automatic system reaction.

NOTE

The PC elements SEQ and STEP cannot be used with redundant processing.
Instead the PC elements GRC and P_STEP must be used.

3.1.11.4 Parallel Processing with External Voting

For safety a single or even a double fault must not impede a needed trip of the plant (for example a boiler or a turbine). Additionally, for high availability usually it is required that a single fault must not activate a trip.

Safety can be increased through the use of multiple safety channels working in parallel.

In the following paragraphs the parallel configurations supported by Advant Controller 160 and its Processor Modules are shown.

Parallel Processor Modules

Any Processor Module of the type PM640, PM644, PM645, or PM646 can be used for parallel processing of the same application program within one controller. Such configurations can be used for safety system applications. The voting is to be done externally with use of a specific signal voter device.

The following configurations are proposed:

- **Dual parallel Processor Module**
  Two Processor Modules within one station with separate output modules and common set of input modules (Figure 3-30).
- **Triple parallel Processor Module**
  Three Processor Modules within one station with separate output modules and common set of input modules (configuration not shown, similar to dual parallel Processor Module).

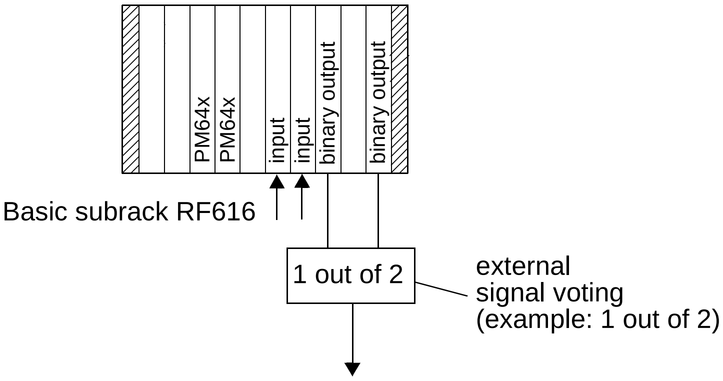


Figure 3-30. Dual Parallel Processor Module within One Advant Controller 160

Parallel Stations with PM645C

PM645C supports parallel processing of the same application program within separate stations. Two or three controllers are used for such configurations, but no system redundancy is used. The voting is to be done externally with use of a specific voter device.

The following configurations are proposed:

- **Dual parallel station**
  Two Processor Modules within separate stations each with its own set of I/O modules, sensor signal exchange via high speed serial link (configuration not shown, similar to triple parallel station).
- **Triple parallel station**
  Three Processor Modules within separate stations each with its own set of I/O modules, sensor signal exchange via high speed serial link (Figure 3-31).

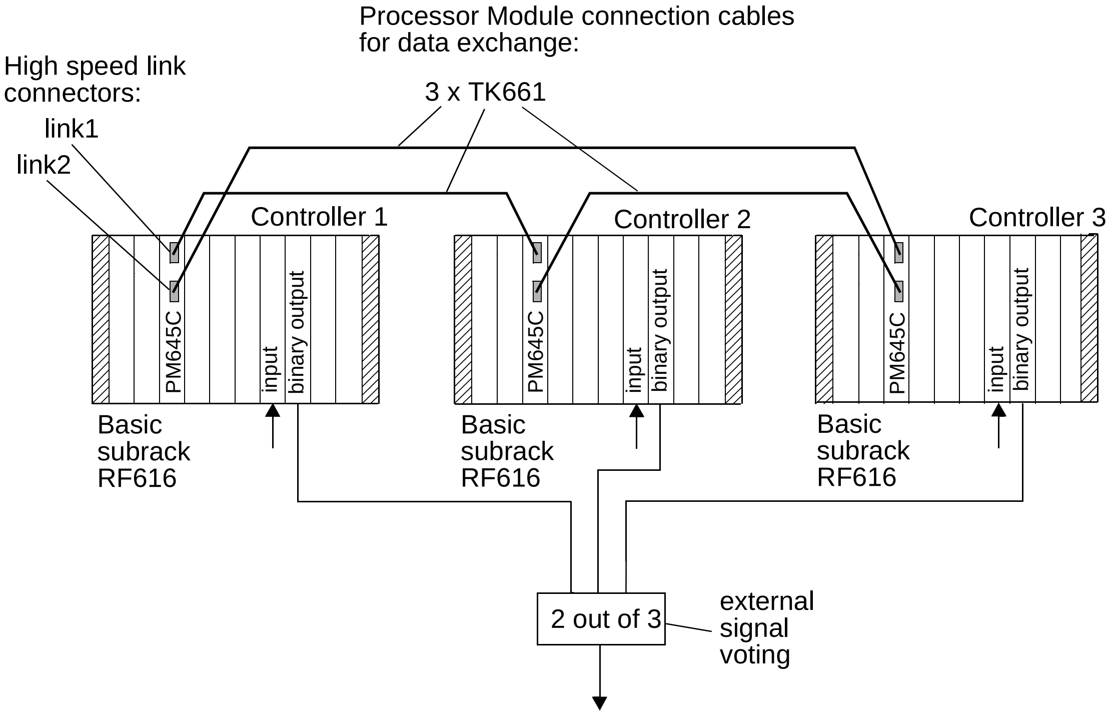


Figure 3-31. Triple Parallel Configuration with Three Advant Controllers 160 Operating in Parallel, Data Exchange via High Speed Serial Links

Dependent on the specific configuration **additional HW modules and cables for parallel processing** are needed:

- The parallel Processor Modules within different stations must be connected with one another via its high speed serial link interfaces. Therefore one cable set TK661 is to be used per connection.
- For configurations with parallel Processor Modules the output signals to be provided via two respectively three separate output modules must be voted upon externally. Therefore specific voter devices must be used.

  For e.g. Turbine Protection of ABB Turbines three solenoid valves with electrohydraulic 2 out of 3 voting is the standard solution.

3.1.11.5 Parallel Processing for Safety System Applications

For safety a single or even a double fault must not impede a needed trip of the plant (for example a boiler). Additionally, for high availability usually it is required that a single fault must not activate a trip.

Safety can be increased through the use of multiple safety channels working in parallel.

In the following paragraph the parallel configurations supported by Advant Controller 160 and its Processor Modules are shown.

Parallel Stations with PM646

PM646 supports parallel processing of the same application program within separate stations. Three controllers are used for such configurations, but no system redundancy is used.
The voting is to be done internally with use of a specific PC elements and externally with the use of a relay matrix.

The following configurations are proposed:

- **Triple parallel station**
  Three Processor Modules within separate stations each with its own set of I/O modules, sensor signal exchange via high speed serial link (Figure 3-32).

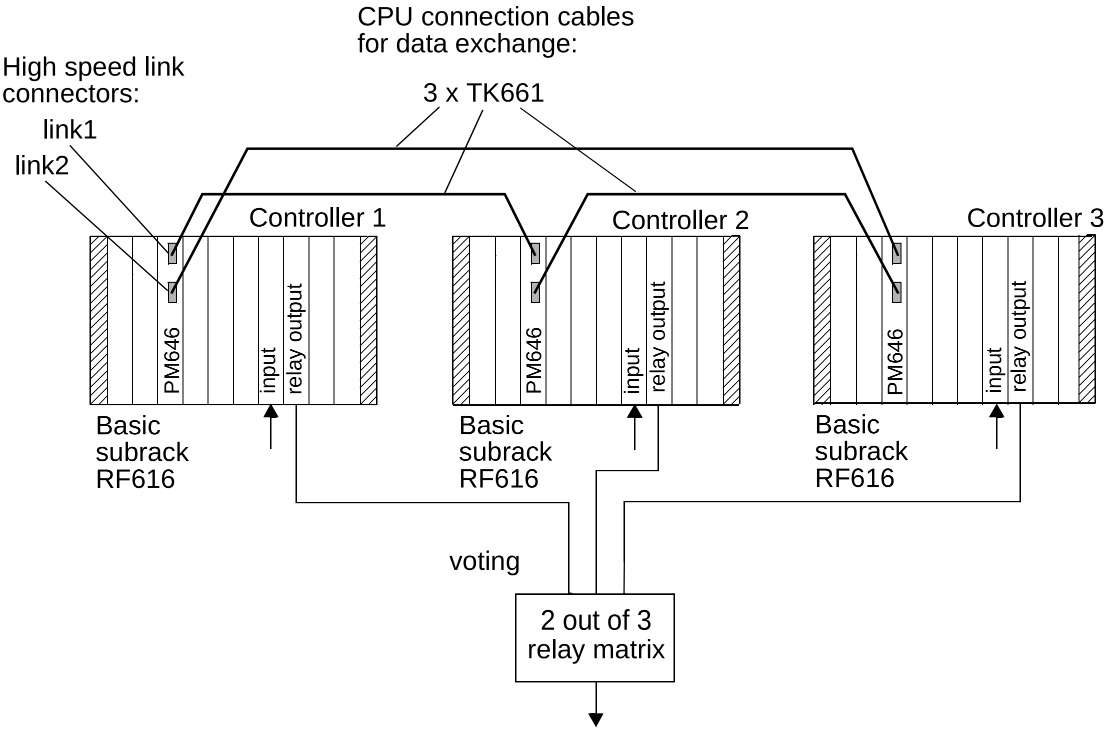


Figure 3-32. Triple Parallel Configuration with Three Advant Controllers 160 Operating in Parallel, Data Exchange via High Speed Serial Links

Dependent on the specific configuration **additional HW modules and cables for parallel processing** are needed:

- The parallel Processor Modules within different stations must be connected with one another via its high speed serial link interfaces. Therefore one cable set TK661 is to be used per connection.
- For safety applications the relay module DX610 can be used.

  The relay module DX610 allows configurations for 2 out of 3 evaluation of the outputs (Figure 3-32) with deenergize to trip.

3.1.11.6 1 out of 2 CPU Redundancy Configuration

Summary

The 1 out of 2 CPU redundancy is designed as a master slave hot standby solution. The slave always balances its historical values to that of the master, in order to guarantee bumpless switchover in case of a failure of the master.

The Processor Modules PM645A, PM645B, or PM646 can be used. The following description concerning configuration shows the Processor Module PM645. For configuration of PM646 only substitute PM645 for PM646.

Hardware Configuration

Place the 2 Processor Modules in one station (slots 3 to 8 are allowed). Give in the number of the redundancy address for each redundant PM645 or PM646 at the PM-No. selector on the front of the Processor Module (only the redundancy numbers 1 and 2 are valid). Connect the redundancies 1 and 2 via high speed serial link (cable TK662) by connecting link 1 on both Processor Modules.

A slave with missing connection to the master goes immediately to the defective state.

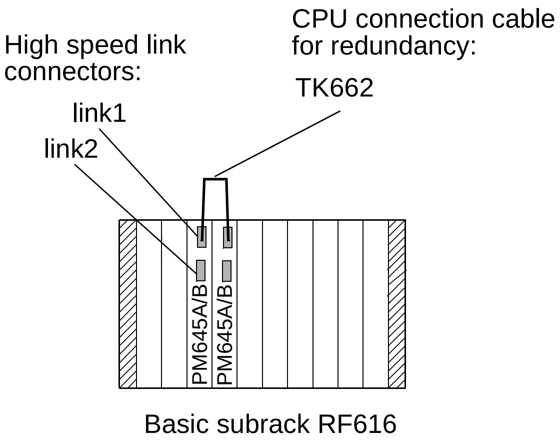

High speed link connectors:
link1
link2
CPU connection cable for redundancy:
TK662
PM645A/B
PM645A/B
Basic subrack RF616

Figure 3-33. Dual Redundant Processor Module within One Advant Controller 160

DB Element PM645, Base part

Terminal values:

NAME	CPUMODULE (unique module name, 20 characters)
BUS	Bus number of main AF 100 (x – y)
STATION	AF100 Station number (1 to 47 for redundant CI630, 1 to 79 for non redundant CI626/CI630)
POSITION	Position of the Processor Module with CPU# = 1 in the station (3 to 8)
IMPL	1
TYPE	PM645

DB Element PM645, Redundancy part

Terminal values:

REDUNDAN	YES
RED_MODE	CPU
TR_MODE	PLAN or UNPLAN → Tracking planned or unplanned (see below)
EXTERNOK	NO or YES (see Reference Manual Data Base Elements)
RBUS1	Bus number of main AF 100 (x – y)
RSTAT1	Station number of the Processor Module with CPU-Nr. = 1
RPOS1	Position of the Processor Module with CPU-Nr.=1 in the station (3 to 8)
RBUS2	Bus number of main AF 100 (x – y)
RSTAT2	Station number of the Processor Module with CPU-Nr. = 2
RPOS2	Position of the Processor Module with CPU-Nr.=2 in the station (3 to 8)
RBUS3	Not used with CPU redundancy
RSTAT3	Not used with CPU redundancy
RPOS3	Not used with CPU redundancy.

PC Part

The PC part must contain at least one PC element with historical value, otherwise redundancy is not established. Normally application programs for closed loop control or open loop control contain a lot of such PC elements. In case there is no such PC element any appropriate PC element can be used, for example the memory element SR (Set Reset memory) or the PC element MOVERED (see the following paragraph).

NOTE

> PC element MOVERED must be used as interface for operator command from HMI. See Section 3.1.11.3, Redundant Processing with Internal Voting.

Unplanned tracking

When unplanned tracking mode is configured (DB element PM645/PM646: TR_MODE = UNPLAN), all historical values are transmitted automatically from the master to the slave. No extra engineering work has to be done in contrast to the planned tracking. The transmission guarantees consistency and integrity. That means that all historical data of a control task of the master are transmitted at the end of the cycle and copied to the historical data of the receiving slave control task with the next start of that control task if they are transmitted completely and without errors.

The amount of data transmitted via the HSL determines the delay time effective for the slave. For time critical processes the delay time should be as short as possible. in order to guarantee soft switchover in case of a master failure. Therefore it can be better for an application with a big amount of historical values to use planned tracking. The delay time can be kept low with planned tracking because only the values that are relevant for tracking have to be defined and are transmitted via the HSL.

With unplanned CPU redundancy the same program must run on both partner CPUs. Therefore only one program is built with the tool AdvaBuild. With the configuration of the DB element PM645/PM646 as described before, the program knows, where the two redundant CPUs are placed in the station. Load the program first to CPU #1 via connecting AdvaBuild to CPU #1. Then connect AdvaBuild 2.0 to the CPU 2 and load down the same program again.

Recursions in the application program result in historical values. This “user-made” historical value cannot be detected by the system software. Therefore the PC element MOVERED is available which in addition to a simple move generates a historical value. This PC element must be inserted in the feedback path. In order to avoid unnecessary delay of the tracking the MOVERED should be executed prior to the PC element(s) of the feed forward path. In the slave redundancy not the move from input to output but the move from the historical value input to the output is performed. As for all PC elements the connection of the historical value to the respective input is done automatically.

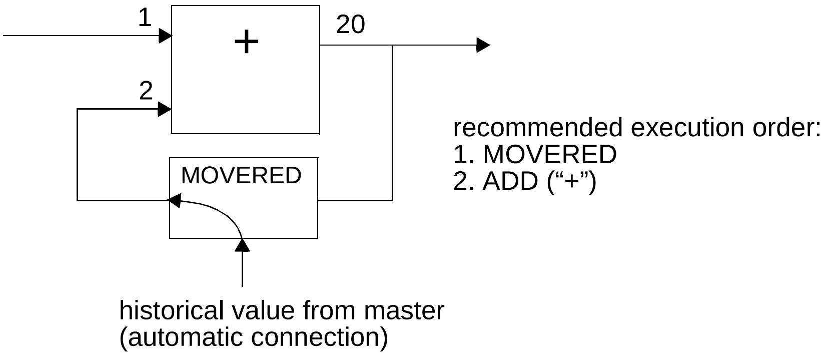


Figure 3-34. PC Element MOVERED for Unplanned Redundancy shown within Slave CPU

Planned tracking

When planned tracking mode is configured (DB element PM645/PM646: TR_MODE = PLAN), only those values which are explicitly defined by the user are transmitted from the master to the slave. The user should choose only those values for transmission that are relevant for the tracking. This has to be engineered separately in contrast to the unplanned tracking. With the DB elements HSLS (send) and HSLR (receive) the data transmission for the values to be sent via the high speed link between the two CPUs can be planned. The transmission is done in a consistent way. That means that all defined values of a control task of the master are transmitted at the end of the cycle and copied to the defined values of the receiving slave control task with the next start of that control task when they are transmitted completely and without errors.

The amount of data transmitted via the HSL determines the delay time in the slave. The delay time can be more than one cycle. A high delay time may cause a bump if a changeover takes place. With time critical processes the delay time should be as short as possible. The delay time can be kept low with planned tracking because only the defined values are transmitted via the HSL.

With planned CPU redundancy usually the same program runs on both partner CPUs. Therefore only one program is built with the tool AdvaBuild. With the configuration of the DB element PM645/PM646 as described before, the program knows, where the two redundant CPUs are placed in the station. Load the program first to the CPU 1 via connecting AdvaBuild to the CPU 1. Then connect AdvaBuild to the CPU 2 and load down the same program again.

PC elements for processing of analog values with relevant dynamic behavior (for example integrator INT, PI function PI) have specific inputs for balancing: input BALREF for the analog balancing value, input BAL for the binary balance command. These inputs can be used for planned tracking: input BALREF for the respective tracking value from the other Processor Module provided via HSL and input BAL for the output TR_GRANT of the DB element PM645/PM646 within the own CPU. Within the master CPU the output TR_GRANT is logical 0 which means that the PC elements are processed in normal operation mode and the tracking values are not considered. If the slave is in tracking mode (CPU is slave and the master is ready) the output TR_GRANT is logical 1 and by that way the connected PC elements are tracked with use of the tracking values from the master at the inputs BALREF. The other PC elements with relevant dynamic behavior are to be connected to its tracking values and to the output TR_GRANT in a similar way.

If—in addition to the tracking for redundancy—balancing is also needed for normal operation (for example a PI controller in manual mode) specific PC element configurations are to be used for the selection of the effective balancing value and balance command.

Figure 3-35 shows the configuration of planned tracking for an integrator. The additionally inserted PC element SW-RED is only necessary for 2 out of 3 redundancy.

If it is intended to use special application programs also within 2 out of 3 redundant stations, the PC element SW-RED should be included as shown in the figure above, even if only two CPUs are used. Thus it will be very easy to include a third CPU later.

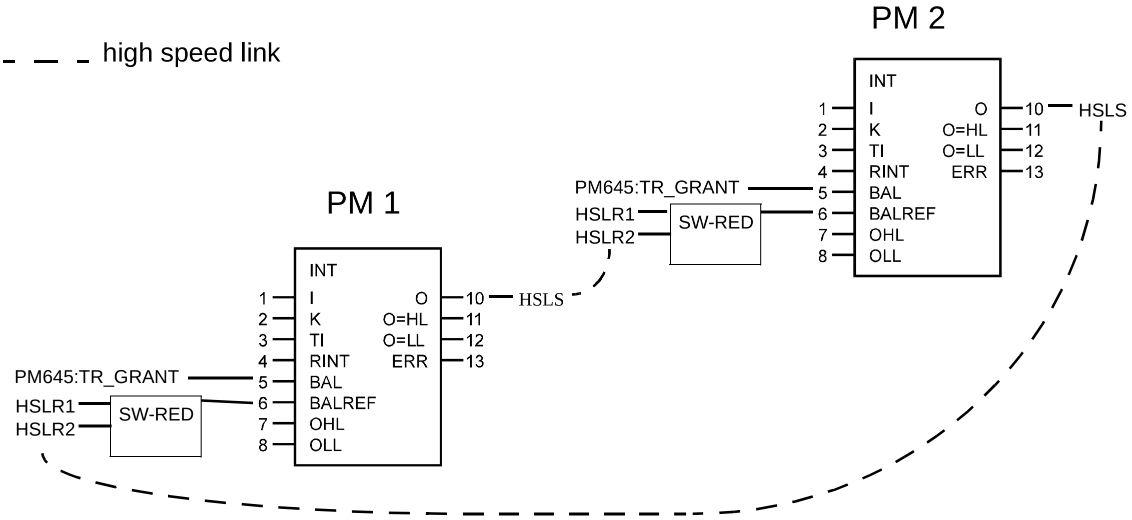


Figure 3-35. Planned High Speed Link Connection with HSLS and HSLR

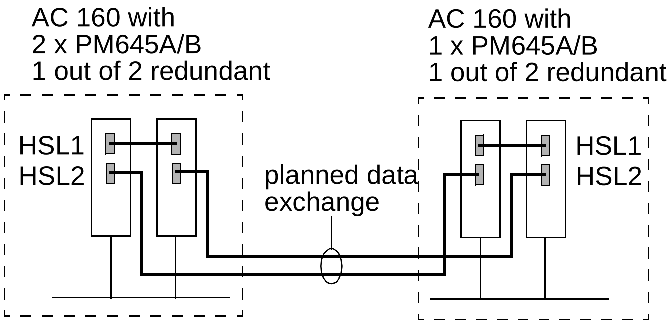
Additional planned signal exchange with external CPUs

In addition to the signal exchange for tracking, it is possible to exchange planned signals for example measured values with a further redundant or non-redundant CPU.

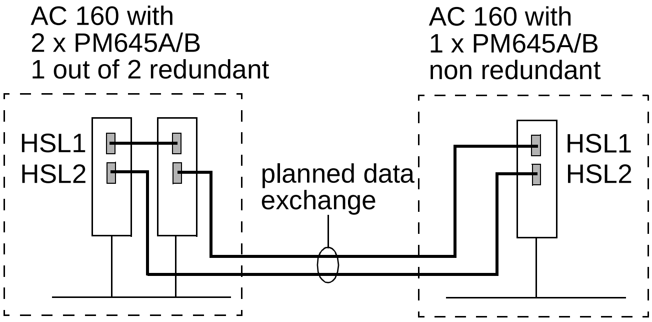
With CPU redundancy only, the link 1 on both CPUs is used. Link 2 is not connected and can be used for other purposes. It is possible to connect link 2 of both CPUs with another redundant or non redundant CPU via high speed serial link cables in order to transmit planned data (Figure 3-36). The transmission of the planned data can be configured via the DB elements HSLS and HSLR. This communication has to be engineered separately on both CPUs.

Different from signal output via output modules or AF 100 where only the master Processor Module puts out its values both master and slave send the planned signals via the high speed serial links.

In case of unplanned tracking the terminal TR_MODE of the DB element PM645/PM646 must be defined as *UNPLAN*.



a) planned data exchange with a redundant pair of Processor Modules



b) planned data exchange with a non redundant Processor Module

Figure 3-36. Planned Signal Exchange of a 1 out of 2 Redundant CPU

3.1.11.7 Redundant Modbus Configuration

Summary

A pair of PM645/PM646 is used in 1 out of 2 CPU redundancy to connect a foreign system with the MODBUS protocol to the AC160.

The PM645/PM646 are running in a master and slave hot stand-by configuration in the unplanned tracking mode. The foreign system is connected via two lines on the second serial interfaces of the PM645/PM646. Both PM645/PM646 are working independent as MODBUS slaves with standard system parameters.

The slave always balances its historical values to that of the master, in order to guarantee bumpless switchover in case of a failure of the master.

The Processor Modules PM645A, PM645B, or PM646 can be used. The following description concerning configuration shows the Processor Module PM645. For configuration of PM646 only substitute PM645 for PM646.

Redundancy specials

To handle the redundant MODBUS protocol between the MODBUS-Master in the foreign system and the MODBUS-slaves in Advant Controller160, it is necessary to use the two special PC elements RED-STAT and MONO-UT.

Redundancy status

For the foreign system, which is working as MODBUS master, it is important to know which of the MODBUS slaves (PM645) runs in the master mode of the redundancy. Only this PM645 is able to send process values over the bus.

The output signal at the terminal MASTER of the PC element RED-STAT provides this information.

MASTER = 1 → The PM645 is working as redundancy master

MASTER = 0 → The PM645 is working as redundancy slave

It is also necessary to know the status of the redundant partner PM645. A defective PM645 is not able to report his own status.

The output signal at the terminal PARTNER of the PC element RED-STAT provides this information.

PARTNER = 1 → The partner PM645 is ok

PARTNER = 0 → The partner PM645 is defective

Supervision of MODBUS data transmission

On the PM645 working as MODBUS slave there is no MODBUS protocol supervision available. For this reason you are not able to detect faults on the protocol handling or a break of the protocol or the cable.

The supervision of a running MODBUS transmission has to be designed with a life-signal. The MODBUS master generates a changing signal and each MODBUS slave checks the changing of this signal within a determined time.

With the PC element MONO-UT you are able to design a independent transmission supervision for each channel of the redundant MODBUS protocol.

The cycle time of the life signal is depending on the amount of signals which must be transmitted over the MODBUS interface. Make sure that the changing of the life signal could be transmitted at each MODBUS cycle. The supervision time of the PC element MONO-UT should be three times of the cycle time of the life signal.

The output O of the PC element MONO-UT indicates the status of the transmission.

O = 1 → life signal transmission ok

O = 0 → life signal transmission disturbed

In the case of a transmission disturbance the PM645 is set to defective.

External acknowledge

The status "defective" of a PM645 can be acknowledged in two ways after the reason for this error message was eliminated.

- Press the push button on the front panel of the PM645
- Use the external acknowledge "QUIET" of the PC element RED-STAT

MODBUS specials

For a detailed description of the MODBUS functions of the PM645 see also Section 3.2.7.1, Local Operator Station.

In the following you find some additional hints for connecting a foreign system with a redundant MODBUS protocol.

PM645 Standard settings for MODBUS protocol

This settings are fixed in the PM645 program, they can not be changed.

Communication port:	**Com B**, with RS 232,
	Pin 2 = TxD, Pin 3 = RxD, Pin 5 = SGND
Line characteristics:	9600 Baud
	1 start-, 8 data-, no parity-, 1 stop-bit

Requirements for redundant MODBUS protocol

Each MODBUS master of the foreign system is directly connected point to point to a MODBUS slave PM645.

The MODBUS protocol must runs on both lines.

Both MODBUS lines run independent. They are not synchronized.

Both slaves are working with the same MODBUS function codes, addresses and data.

The master can read the same values from both slaves.

The master must write the same data to both slaves. The telegrams will be acknowledged by both slaves, but only the data which are transmitted to the redundancy master will be send to the AC160 bus.

MODBUS function codes

The MODBUS function codes 01, 02, 03, 04, 05, 06, 07, 08, 15, and 16 are supported. See Table 3-8.

MODBUS addresses, PARDAT elements

Only the small MODBUS address model is available.

For MODBUS address calculation and corresponding PARDAT no. and PARDAT type see Section 3.1.7.1, Local Operator Station.

For data exchange via MODBUS use the PARDAT DB elements.

PARDAT(B) for Boolean Parameters

PARDAT(I) for Integer Parameters

PARDAT(II) for 2× Integer Parameters

The DB elements

PARDAT(IL) for Integer long (32 bit) Parameters

PARDAT(R) for Real Parameters

have no equivalent standard Format on the MODBUS.

Each defined PARDAT element occupies 32 binary addresses or 2 register addresses on the MODBUS regardless whether it is empty or full.

Application

In the following program chart (see Figure 3-37 and Figure 3-38) you will find an example of a minimum structure of a redundant MODBUS application.

This program is running on both PM645.

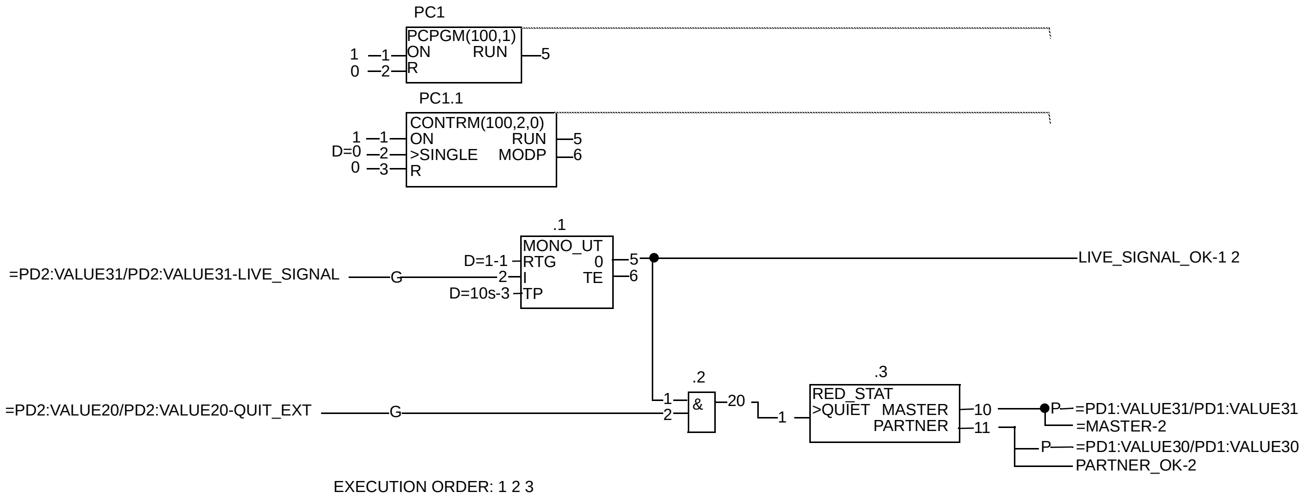


Figure 3-37. Example of PC Diagram of a Redundant MODBUS Application, Part 1

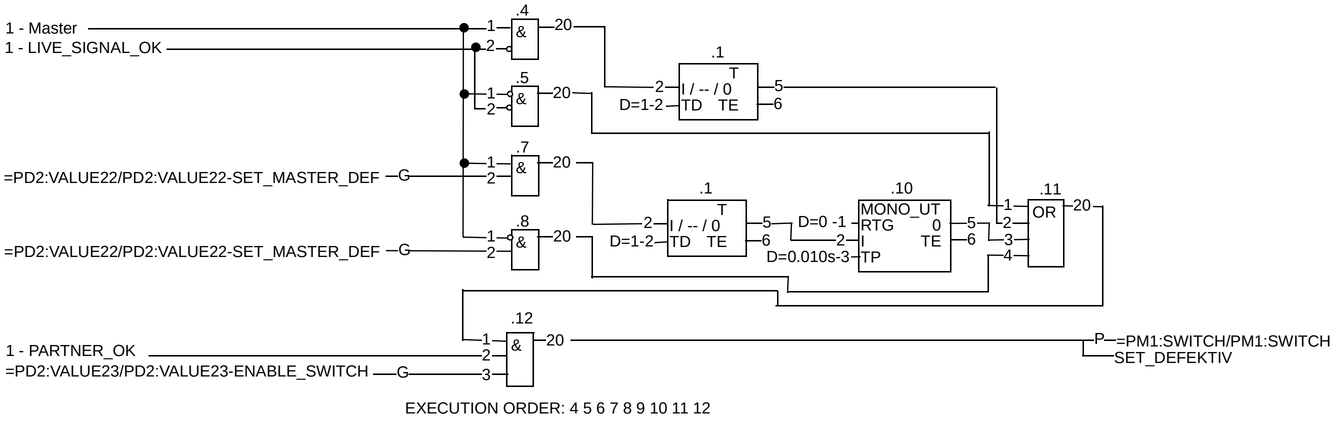

1 - Master
1 - LIVE_SIGNAL_OK
=PD2:VALUE22/PD2:VALUE22-SET_MASTER_DEF
=PD2:VALUE22/PD2:VALUE22-SET_MASTER_DEF
1 - PARTNER_OK
=PD2:VALUE23/PD2:VALUE23-ENABLE_SWITCH
.4
.5
.7
.8
.12
&
.1
I / -- / 0
TD TE
D=1-2
.10
MONO_UT
RTG
TP
D=0
D=0.010s
.11
OR
=PM1:SWITCH/PM1:SWITCH
SET_DEFEKTIV
EXECUTION ORDER: 4 5 6 7 8 9 10 11 12

Figure 3-38. Example of PC Diagram of a Redundant MODBUS Application, Part 2

3.1.12 System Clock Synchronization

Methods and System Components

Dependent on the specific system configuration using Advant Controller 160 different methods are available for synchronization of the system time:

- Time and date can be set via AS 100ES, AdvaSoft for Windows and can be downloaded to Advant Controller 160 at the same AF 100. Advant Controller 450 can be loaded from AS 100ES via front connector.
- Clock synchronization via Advant Fieldbus 100 can be done by a controller which is configured as time master through sending the actual time as broadcast message once a second via Advant Fieldbus 100. Any Advant Controller 450 [1] or Advant Controller 160 but only one can be configured as time master. The other controllers and the stations are time slaves, receive the time sent and update its internal clocks.
- External clock synchronization with use of a minute pulse input is supported by Advant Controller 160 (connected to the I/O port on Processor Modules PM645 or PM646) and by Advant Controller 450. The minute pulse must be provided by a central clock, for example as output of a radio clock.
- External time signal using a DCF77 clock connected to the Com B serial line connector of Processor Modules PM645 or PM646 of Advant Controller 160.
- In case of missing synchronization the internal clocks of the controllers and stations provide the actual time with reduced accuracy.

Table 3-10 gives an overview on the controllers usable as time master for synchronization via AF 100 with its used methods and needed system components for system time input and synchronization.

Table 3-10. System Time Masters for Synchronization via AF 100

System time master	System time input and synchronization for the time master
Advant Controller 450	Manual setting of time and date via AS 100ES(1) directly connected to Advant Controller 450 and external synchronization via minute pulse input of TC520.
Advant Controller 160	Manual setting of time and date via AS 100ES, AdvaSoft 2.0 for Windows NT and external synchronization via minute pulse input to PM645, PM646 or external synchronization via DCF77 time signal.

(1) With option Online Builder and Engineering Board

---

[1] Advant Controller 450 can only be used as time master on AF 100.

Configurations

Typical configurations as normally used for control systems are:

- Autonomous control system with Advant Controller 160 and Operator Station AdvaSoft 2.0 for Windows NT.
- Control system with Advant Controller 160 and superordinate Advant Controller 450 and Operator Stations AS 500OS.
- Multi-processor configurations.

Autonomous Control System with Advant Controller 160

The configuration is shown in Figure 3-39.

The operator station AdvaSoft is time source, the Advant Controller 160 to the left is time master and can be synchronized via an external minute pulse. The other controllers are time slaves. The time master can contain a single Processor Module or dual or triple redundant Processor Modules or up to six Processor Modules for multiprocessing.

In case of redundant Processor Modules, the minute pulse is connected to each Processor Module. The active Processor Module is always the time master.

In case of single Processor Modules or station redundancy, the minute pulse is connected only to one Processor Module in one controller, which is the time master.

The time master sends time and date cyclically once a second as broadcast message. All other controllers receive these messages and set its internal clocks. Between two consecutive minute pulses the time master's internal clock runs independently ever providing the actual time.

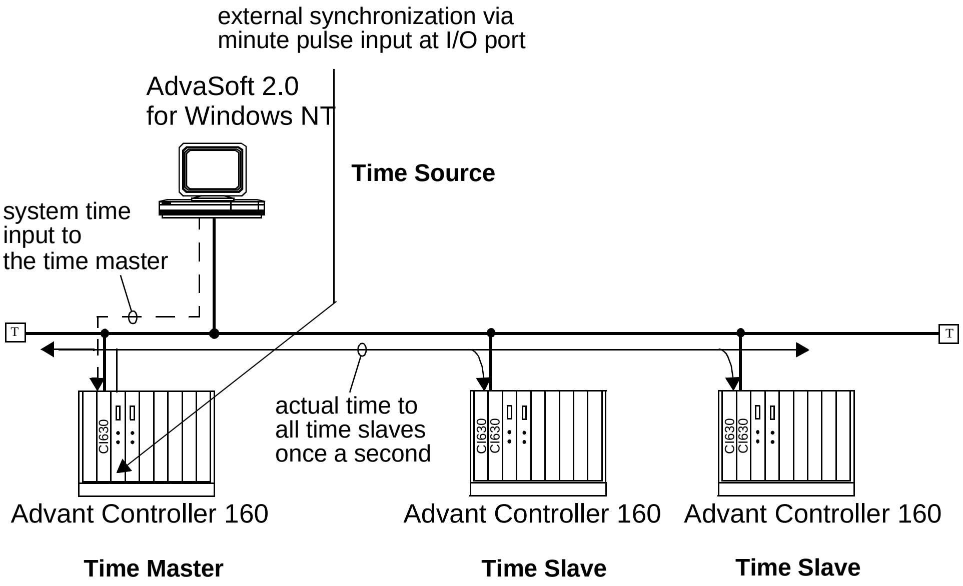


Figure 3-39. System Clock Synchronization within an Autonomous Control System using AC 160 and AdvaSoft 2.0 for Windows NT

Control system with Advant Controller 450 and AS 500OS

The configuration is shown in Figure 3-40.

Advant Controller 450 is time master. It can be synchronized via MB300 or via an external minute pulse. The other controllers at the Advant Fieldbus 100 are time slaves.

Advant Controller 450 cyclically sends time and date once per second as broadcast message via AF 100. The other controllers receive these messages and set its internal clocks.

Between two consecutive minute pulses the time master's internal clock runs independently ever providing the actual time.

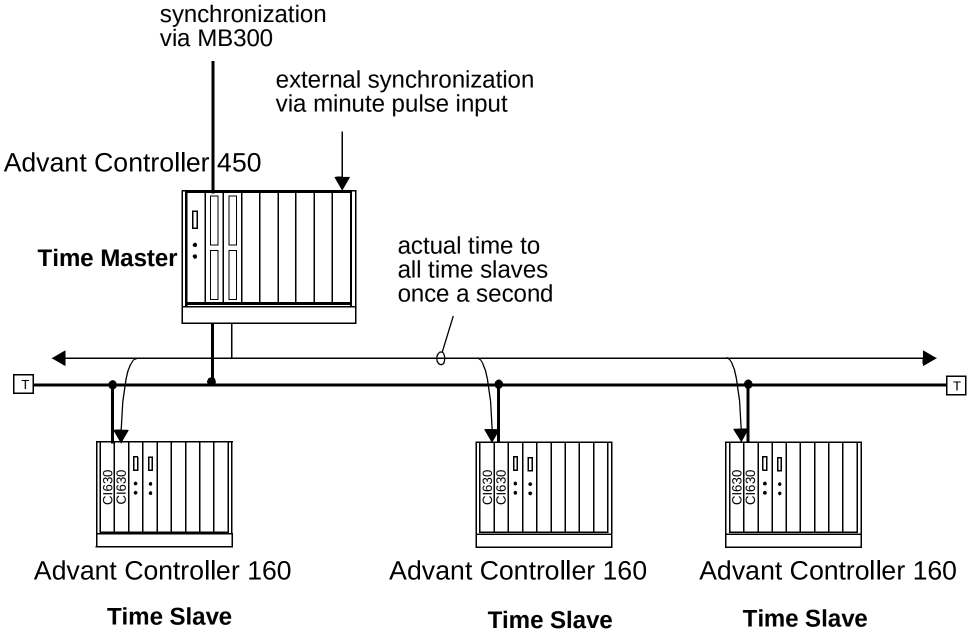


Figure 3-40. System Clock Synchronization within a Control System using AC 160 with Superordinate AC 450 and AS 500OS

Synchronizing Multi Processor Systems with Minute Pulse

The configuration is shown in Figure 3-41. All Processor Modules receive the same minute pulses from an external clock. Pin 4 (external timesync) and Pin 6 (GND) of the I/O port are used.

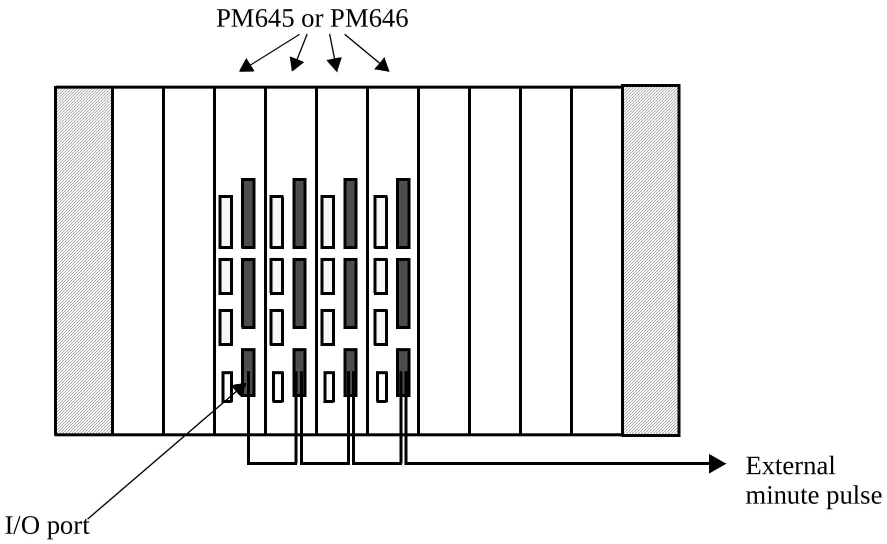


Figure 3-41. Time Synchronization of Several Processor Modules

Connecting a DCF77 Clock to Com B

Although all Processor Module have a serial port **Com B**, only PM645 and PM646 are capable to connect to a DCF77 clock. The connection depends on the type of DCF77 clock being used. The following example is for the "Hopf 7001 DCF" clock:

Table 3-11. Connection Hopf 7001 DCF to Com B

Signal from Hopf 7001 DCF	**Processor Module Com B**
Pin 2 – TxD	Pin 3 – RxD
Pin 7 – GND	Pin 5 – GND

3.1.13 Memory Requirement

At start-up the application program of the Processor Modules is copied from the nonvolatile memory into SRAM memory.

NOTE

> The Processor Modules PM640, PM644, PM645 and PM646 contain enough memory for all applications. Therefore the size of the memory is normally not be considered for practical use.

Nevertheless you can get the exact memory requirement for the PC section of your application program by the Function Chart Builder command **PC Section | Memory Calculation**.

Once the application is prepared and downloaded to the target, you can obtain an exact report about free memory resources on the target via the *Status Report* window. This function considers PC and DB part of your application.

During the execution of an *on-line change*, extra RAM is needed. If the memory is already consumed by a large application, you are alerted by the Function Chart Builder running on the Engineering Station with the warning, “Not enough memory on target available”.

The memory requirement for each PC or DB element you will find in following manuals:

- PC Elements Advant Controller 160 Reference Manual
- Data Base Elements Advant Controller 160 Reference Manual.

3.1.14 CPU-Optimization, Load Calculation

This section deals with the program execution capacity of an Advant Controller 160. It provides answers to questions such as, “What load can I expect from my application?”
It also provides a survey of how the application program influences the load on an Advant Controller 160. In the conclusion, you can find recommendations for the reduction of system load.

The performance of an Advant Controller 160 depends on the number of Processor Modules used and on the individual CPU load of the application program. The CPU load of an application program is determined by:

- CPU load of all executable units (PCPGM, CONTRM, MASTER, SEQ)
- CPU load of DataSet Peripheral communication (DSP) on Advant Fieldbus 100
- CPU load of MVI data block communication (MVB)
- CPU load of event detection.

What is the CPU to do?

The different functions in an Advant Controller 160 are allocated to different priorities. This means that a function with a higher priority takes precedence over a function with a lower priority if both functions are activated simultaneously. A schematic presentation of the priority system follows.

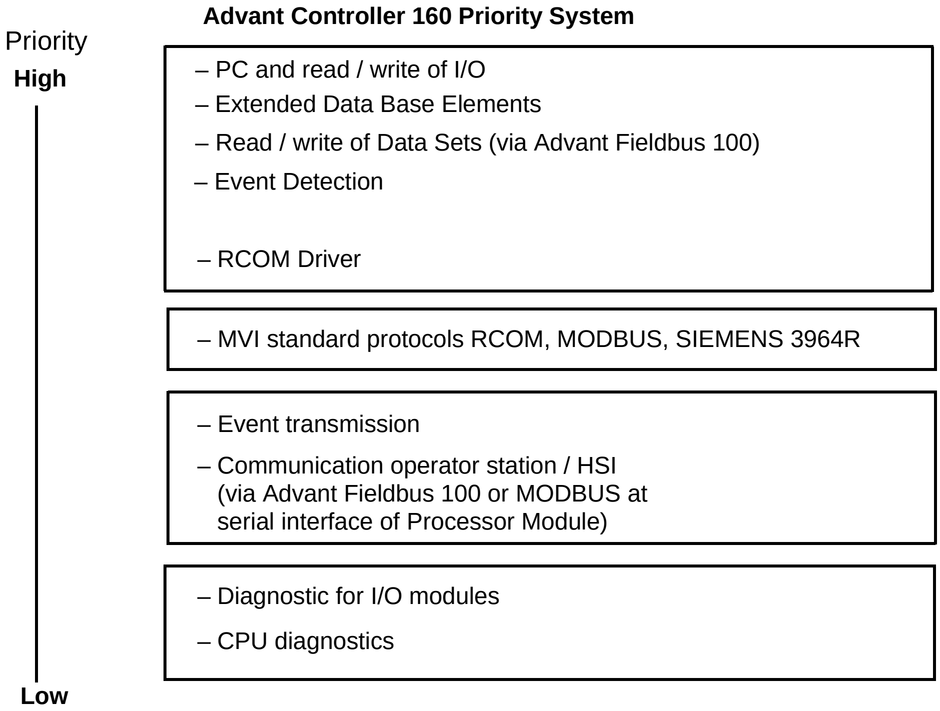

Advant Controller 160 Priority System
Priority
High
– PC and read / write of I/O
– Extended Data Base Elements
– Read / write of Data Sets (via Advant Fieldbus 100)
– Event Detection
– RCOM Driver
– MVI standard protocols RCOM, MODBUS, SIEMENS 3964R
– Event transmission
– Communication operator station / HSI (via Advant Fieldbus 100 or MODBUS at serial interface of Processor Module)
– Diagnostic for I/O modules
– CPU diagnostics
Low

Figure 3-42. Advant Controller 160 Priority System

The user is not normally concerned with priority levels since these are managed automatically by the system, but the user should be aware of the priority system and that the system might stall if the system is heavily loaded.

3.1.14.1 CPU Load of Executable Units

The CPU load of executable units (PCPGM, CONTRM, MASTER, SEQ) is determined by the execution time of the executable units and their cycle time.

To isolate each executable unit from data changes during execution, the execution is commenced by an input phase and ends with an output phase. This data exchange is performed by GET elements for the input phase and PUT elements for the output phase. The PUT and GET elements are internal function blocks of the Processor Modules.

The execution time of an executable unit of type CONTRM, MASTER or SEQ consists of:

- Execution time of the module header element CONTRM, MASTER or SEQ
- Execution time of all PC elements included in this executable unit
- Execution time of GET and PUT elements for the input and output phases.

You can find the execution time of all PC elements including module header elements in the *PC Elements Advant Controller 160 Reference Manual.*

To reduce load for certain PC elements (for example AND, OR, SR or XOR) in-line code is automatically chosen by the engineering tool. Note that for every in-line code sequence, the execution time of the in-line begin and end element must be added. You can find the execution time of these PC elements including in-line begin and end elements in *PC Elements Advant Controller 160 Reference Manual.*

The execution time for a single PC element or for all PC elements within a control module or a block can be automatically computed by the **PC-Section | Computing Time | Unit** and **PC-Section | Computing Time | Element** commands of the Function Chart Builder running on the Engineering Station. Reduction of execution time due to in-line coding of PC elements (for example AND, OR, SR and XOR) is not taken into account by these Function Chart Builder commands.

Every connection of a PC element terminal to any of the following terminals causes the execution of a GET or PUT element:

- DB element terminal
- Terminal of a PC element within another executable unit.

If more than one PC element terminal within a certain executable unit is connected to the same DB element, only **one** GET or PUT element is executed.

The execution times of GET and PUT elements for connections to all kinds of DB element terminals are listed in the *DB Elements Advant Controller 160 Reference Manual.*

An executable unit including the module header element, PC elements, and GET and PUT elements is executed with the cycle time specified by the first call parameter (*C1*) of the module header element (CONTRM, MASTER or SEQ).

The CPU load L_{exec} (in percent) of all executable units can be calculated by the following formula:

$$L_{exec} = \sum_{i} \frac{N_i \cdot T_i}{C_i} \cdot 100\%$$

where

T_i = execution time of function *i* (in ms)

N_i = number of function *i*

C_i = cycle time of function *i* (in ms)

The functions are:

- PCPGM
- Module header elements CONTRM, MASTER, SEQ
- PC elements
- GET and PUT elements.

The cycle times C_i to be considered for the respective elements is given as follows:

• PCPGM	Own cycle time (call parameter C1)
• Module header element (CONTRM, MASTER or SEQ)	Own cycle time (call parameter C1)
• PC element	Cycle time of the executable unit including this PC element
• GET or PUT element	Cycle time of the executable unit including this element.

3.1.14.2 CPU Load Calculation

See the formula within the *Advant Controller 110 User’s Guide*. The figures given there for the Processor Module PM632 can be adapted to the Processor Modules PM640, PM644, PM645, and PM646 through correction with the factor 3 which includes the improved performance of the Advant Controller 160 Processor Modules.

CPU execution times and CPU load figures of PM632 are to be divided by 3.

The maximum load available for the application program within Advant Controller 160 as shown in Table 3-13 must be considered.

3.1.14.3 How can an Excessive CPU-load be Reduced?

First, analyze the application to determine where to take the most effective optimization action. Principally, take optimization action in five areas: I/O, PC, communication, event detection, Extended DB elements (see *AMPL Configuration Advant Controller 100 Series Reference Manual for description of Extended DB elements*). As usual with optimization, it is most profitable to optimize the part which uses the most CPU-power.

Recommendations for optimization in these four areas are given below.

I/O System

- Insert all I/O modules you have configured. Not inserted but configured I/O modules cause additional system load because of error treatment and additional accesses to the missing module.
- I/O signals are scanned with the cycle time of the specific executable unit (that is CONTRM) which contains the connections to these I/O signals. If there are I/O signals used which need to be scanned less often than the cycle time of the executable unit in the PC (that is analogue signals) you can configure those signals in a separate executable unit with a cycle time as low as necessary.
- Select scanning cycle times for the AI channel as large as possible. Of course, the time resolution requirement must be considered.

PC part

- Check that no executable unit is executed with an unnecessarily short cycle time.
- If possible, break out parts of an executable unit or executable units and allocate them to a longer cycle time.
- Utilize the option to block executable units when they need not be executed. It is also possible to introduce a BLOCK element here when only parts of an executable unit can be blocked.

Communication

- Use cycle times as long as possible for configuring DB elements Data Sets or MVB's.
- For cyclic execution of DB element MVB do not use terminal EXECUTE to avoid additional PC programming. Configure the MVB for cyclic execution instead.
- If possible use communication modules instead serial link of Processor Module for certain protocols (that is MODBUS, see Section 3.1.5.1, Provided Link Types).

Event Detection and Extended DB elements

- Consider that one event detection function with a very small scan time increases the load for **all other** event detection functions drastically.

3.2 Capacity and Performance

This section provides technical data that is relevant from a controller viewpoint. Much of the detailed technical data about the Processor Modules in given in Appendix B, Processor Modules. You can find references to technical information included in Appendix A, Hardware Components.

3.2.1 Product Structure

The primary structure outlined in Section 1.8, Product Overview is the basis of the presentation.

3.2.2 General System Utilities

3.2.2.1 Processor Modules

General Technical Data, Capacity

Table 3-12. Technical Data of the Processor for the Application Program

Data	PM640, PM644, PM645, PM646
Processor	MC68360
Clock frequency	33 MHz (1)

(1) Processor Modules without BSE article number are equipped with a 25 MHz clock. The performance of these Processor Modules is reduced accordingly.

CPU load calculation

Independent of any CPU configuration the maximum load measured with PC element SYSL must not exceed a value of 70% within one CPU.
In multi-CPU environment the execution of application programs will be slowed down caused by arbitration and waiting times leading to a reduced data flow via the common backplane bus. Therefore the size (or the cycle time) of the application program has to be decreased to keep the CPU load below the upper limit (70%).
For example a single CPU executing an application program with a load of 60% (SYSL = 60%), the same program would lead to a load of 70% (SYSL = 70%) if this CPU is plugged in to a controller with a total amount of 4 CPUs.

Load Fluctuation

The more Processor Modules you have in one station, the more the load is fluctuating. So for multi-processing configurations applications with cycle times < 8 ms are not recommended!

To determine the CPU load for an Advant Controller 160, the maximum load values available for the application program as shown inTable 3-13 must be considered:

Table 3-13. Maximum usable CPU Load for Application Program

Processor Module configuration	Maximum load per PM [%]	Effective load per controller with single PMs [%]	Effective load per controller with redundant PM pairs [%]
2 single PM’s or 1 redundant pair	70	2 × 70	70
4 single PM’s or 2 redundant pairs	70	4 × 60	2 × 60
6 single PM’s or 3 redundant pairs	70	6 × 50	3 × 50

The CPU load of the application determines the performance of an Advant Controller 160. For instructions on how to make calculations, see Section 3.1.14, CPU-Optimization, Load Calculation.

For detailed information on execution times of DB and PC elements, please see *Data Base Elements Advant Controller 160 Reference Manual* and *PC-Elements Advant Controller 160 Reference Manual*.

3.2.2.2 Memory

General Technical Data, Capacity

Table 3-14. General Technical Data, Capacity of Memory

Data	PM640, PM644, PM645, PM646
Static RAM for system and application	2 MByte
Flash PROM for system software	2 MByte
Flash PROM for user built application program	1 MByte (1)

(1) minus 128 KByte for the boot program

Memory Requirement

For detailed information regarding the memory requirements of different PC elements, see the PC element manual.

3.2.2.3 System Clock

General Technical Data of the System Clock

Inaccuracy expressed as drift in time: max. 0.1 ms/s.
(stand-alone system).

When a controller is included in a control network, the clock is synchronized to a master clock, for example, the clock in an operator station or a dedicated controller.
The accuracy is then related to the master clock accuracy.

Relative error in time within the same Advant Fieldbus 100:	max. 10 ms
Relative time error in time within one Advant Controller 160:	max. 1 ms

In case of PM645 and PM646 you can synchronize one controller with single redundant or multiprocessing Processor Modules via external minute pulse signal. This controller is used as master clock in the control network. The aim is to synchronize to an accurate external clock.

Relative error in time when synchronized via external minute pulse signal	max. 0.5 ms

Relative time error with time-tagged events, see Section 3.2.4, Process Interface.

For data of the external synchronization input, see Table 3-15 below.

Table 3-15. PM645/PM646 Clock Synchronization, Electrical Data for Minute Pulse

Data	Value
Input signal	"0" = -30 to +5 V
	"1" = +11.2 to +30 V
Filter time constant	≤ 1 ms
Pulse length	> 10 ms
Triggers at	positive flank

3.2.3 Power Supply

For dimensioning and selection of power supply units, calculation of current consumption, fusing and general guidelines concerning power supply, see Section 3.1.3, Power Supply.

A quick guide of power consumption to use in a very preliminary phase of work on a project or any time you need estimated figures for planning purposes is given below.
Note that typical requirements of power plant control systems are considered:

- redundancy for all central modules
- mixture of analog and digital I/O modules
- all subracks slot must be usable.

In other respects, such as technical data, and so on, please refer to separate documentation:

For individual power supply units SA161 and SA162 see Appendix C, Cabinet Configuration.
Power supply module SA610 and power consumption of I/O modules see: *S600 I/O Hardware, Reference Manual*.

Table 3-16. Estimated System Power Consumption

Subrack	PM640/ PM644/ PM645/ PM646	CI630/ CI631	CI615/ CI610	AI625	AO650	DI63x	DO630	Power Con-sumption (1)	No needed SA610	No needed SA161
Basic station: basic subrack	2	2	2 CI615	1	1	1	1	100 W	1.7	0.4
Basic station: basic subrack + extension subrack	2	2	2 CI615	3	1	7	3	160 W	2.7	0.7
I/O station: basic subrack	-	-	2 CI610	2	1	3	1	80 W	1.3	0.3
I/O station: basic subrack + extension subrack	-	-	2 CI610	4	1	9	4	140 W	2.3	0.6

(1) AC power supply: cos $\varphi > 0.7$

Power Supply Interruption

If power supply is interrupted the operation of the Processor Module will be affected because there is no buffering time. Mains interruption for min. 10 ms and typical. 12 ms at maximum load are buffered by the power supply unit SA610.

3.2.4 Process Interface

General Technical Data, Capacity

Event Handling

Independent from type of event for each event set element (DB element EVS) there is a queue in the Processor Module. You can create up to 32 EVS elements and thus have up to 32 event queues.
These queues can store an event burst. Each queue has the following capacity:

Table 3-17. Size of Event Queue for Event Burst

Type of queue	Buffer size
NORMAL	100 events
EXTENDED	1000 events

If an event burst exceeds the capacity of a queue, the overflow is indicated at the EVS element. For more information see *AMPL Configuration Advant Controller 100 Series Reference Manual*.

The loss of events is also reported to the operator station, AdvaSoft for Windows, by an event with time marked "uncertain".

Relative time error with time-tagged events see Table 3-18:

Table 3-18. Relative Time Errors of Time-tagged Events

Method of event detection	Relative time error
DI650/DI651/DI652/DI685	1 ms
AIC/DIC/Extended DB elements	1 × SCANT (1)

(1) SCANT = cycle time for scanning calculated events. Maximum time error in case of highly loaded Processor Module: 3 × SCANT

For system clock accuracy, see Section 3.2.2.3, System Clock.

3.2.4.1 S600 I/O

General Technical Data, Capacity

Please note that you must consider practical limits when the data below is applied, for example:

- Space in the used cabinet
- CPU load
- Integrity aspects
- Availability aspects.

Table 3-19. Capacity S600 I/O for Advant Controller 160

Data	Value	
No. of I/O extension busses	1 (1)	
No. of basic station	max. 1	
No. of I/O station	max. 7	
No. of extension subrack per station	max. 1	
Total length of bus extension cable	max. 20 m (2)	
No. of I/O modules per station (basic or I/O station)	max. 20 (3)	
No. of I/O modules per controller	max. 151 (4)	
No. of digital input channels	max. 4812 (5)	
No. of digital output channels (only DO modules)	max. 4812 (5)	
No. of analogue input channels	max. 4812 (5)	
No. of analogue output channels	max. 2416 (5)	
No. of submodule carrier SC610	max. 1	
No. of submodules CI532 for SC610	max. 2	
No. of Communication Interface modules for Advant Fieldbus 100 CI626	max. 2 (6)	Total max. 4
No. of Communication Interface modules for Advant Fieldbus 100 CI627	max. 1 (7)	
No. of Communication Interface modules for Advant Fieldbus 100 CI630	max. 4(8)	
No. of Communication Interface modules for Advant Fieldbus 100 CI631	max. 2(9)	

(1) 1 bus line for nonredundant I/O extension, 2 bus lines for redundant I/O extension
(2) Per bus line in case of redundant I/O extension
(3) Slots for additional modules to be considered: Processor Modules, Communication Interfaces, extender modules, power supply modules
(4) For performance reasons max. 75 I/O modules are recommended
(5) Only I/O modules of the specified type with 151 I/O modules. For performance reasons max. no. of 75 modules with up to 1500 I/O channels is recommended
(6) One module for the main control bus, one module for the second subordinate control bus
(7) One module for the second subordinate control bus
(8) Two modules for redundant interface to the main control bus, two modules for the second subordinate control bus
(9) Two modules for the second subordinate control bus

3.2.5 Communication

3.2.5.1 Provided Link Types

General Technical Data, Capacity

Table 3-20. Link Types, Hardware and Software

Link Type	Number of instances	
Advant Fieldbus 100	max. 2 buses	
Bus extension to S600 I/O	max. 1 bus	
High speed link via PM645 or PM646	max. 12 links (2 links per PM) (1)	
PROFIBUS-DP via PM644	max. 6 links (1 link per PM)	
MODBUS (slave function) via second serial interface at Processor Module	max. 1link	
RCOM via submodule CI532	max. 4 links (master) max. 2 links (slave)	Total max. 4 (master) Total max. 2 (slave)
MODBUS via submodule CI532	max. 4 links (master) max. 2 links (slave)	
SIEMENS 3964R via submodule CI532	max. 4 links (master) max. 2 links (slave)	

(1) Links occupied for redundancy and parallel processing within separate controllers:
1 link per CPU for dual configuration, 2 links per CPU for triple configuration

3.2.5.2 Applied Communication

General Technical Data, Capacity

Normally there are no limits in capacity beyond the limits placed by the actual link for the application. Extended information for certain applications are found below.

DataSet Peripheral (DSP) with Advant Fieldbus 100

A DataSet Peripheral can hold 1 to 8 DAT values. Each DAT value represents 32 Boolean, or 1 integer (16 or 32 bit), or 1 real number.
Advant Controller 160 can accommodate max. 200 DSPs per Processor Module for each of max. two communication links on Advant Fieldbus 100.

DataSet Peripherals are cyclically transmitted to their respective destinations, with a cycle time selectable in the range 2 ms to 4096 ms.

Table 3-21. Data Set Communication for Advant Controller 160

Description	Data per AF 100
Total number of data sets (send and receive) per Processor Module	200
Maximum number of data sets (send and receive) per controller	400
DAT elements per data set	1 – 8
Selectable cycle times	2,4 – 4096 ms

Allowed AF 100 Station Addresses

Following AF 100 station addresses are allowed for Advant Controller 160:

- Advant Controller 160 with non redundant CI631 or CI630 or CI627 or CI626: 1 to 79
- Advant Controller 160 with redundant CI630 or CI631: 1 to 47.

3.2.6 Process Control

General Technical Data, Capacity

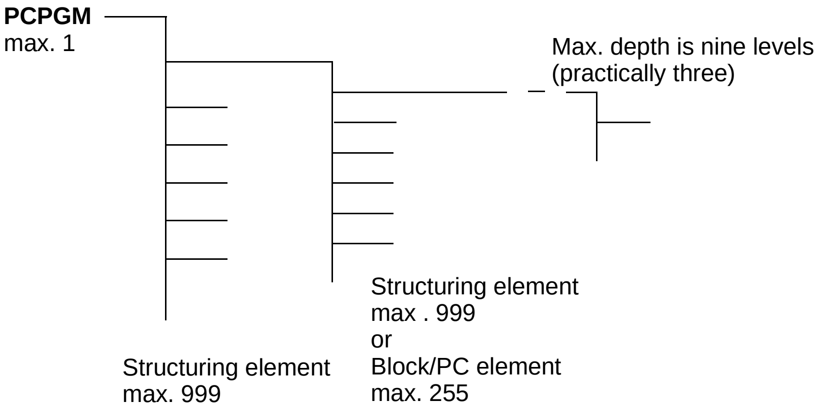
Primarily, an application program for process control is "softly" limited by different considerations like: CPU load, integrity, availability, safety, and so on. You can find information on these topics in part elsewhere in this manual. Some key data put "hard" limits on an application program for process control. The main key data are listed below.

Table 3-22. Key Data, Process Control

Key Data	Maximum Number
No. of I/O channels (corresponds to no. of signals)	See Section 3.2.4, Process Interface
No. of PC programs, PCPGM	1
Levels in structure	9 (practical limit is 3)
Structuring/execution elements: CONTRM SEQ MASTER	total 31

Table 3-22. Key Data, Process Control (Continued)

Key Data	Maximum Number
Structuring/function element: FUNCM STEP SLAVE	total 999 per level in structure
BLOCK	total 255 per level in structure
PC element	
Data transfer and Communication: DAT	5461



Note: Structuring/execution element **CONTRM, SEQ, MASTER**
Structuring/function element **FUNCM, STEP, SLAVE, BLOCK**

Figure 3-43. Structuring Limits

3.2.7 Operator Interface

3.2.7.1 Local Operator Station

General Technical Data, Capacity

The number of local operator stations which are communicating via serial interface at Processor Module using MODBUS protocol to is limited to 1.

3.2.7.2 Central Operator Station

General Technical Data, Capacity

The number of operator stations of the type AdvaSoft for Windows communicating with one Advant Controller 160 is limited to 10.

3.2.8 Availability

The reliability and availability of an Advant Controller 160 and its I/O can be calculated on request. Such a calculation can be adapted to the actual application and it can be extended to include all Advant OCS equipment in an automation system.

3.2.9 Mechanics

General Technical Data

Cabinet Dimensions

Table 3-23. Cabinet Dimensions

Version	Width	Height		Depth	Weight (1)
		IP21 (2)	IP54 (3)		
Single cabinet - RM5yy	800/870 mm (4)	2150 mm	2150 mm	525 mm	145 kg
Double cabinet - RM5yy	1600/1670 mm (4)	2150 mm	2150 mm	525 mm	270 kg

(1) The weight does not include equipment to be installed within the cabinet.
As an average weight of a "typical content" of one cabinet, use 100 kg.
The exact weight must be calculated with respect to the actual design.
(2) IP21 = ventilated version.
(3) IP54 = sealed version.
(4) Including end plates.

Protection Rating

RM5yy cabinets are available with the following degree of protection rating:

Table 3-24. Protection Rating

IEC publication 529	NEMA-U1 classification
IP21 ventilated	NEMA Type 1 and 2 ventilated
IP41 "tropic"	NEMA Type 1 and 2 non-ventilated
IP54 sealed	NEMA Type 5

Electro Magnetic Compatibility, EMC

RM5yy

All RM5yy cabinet versions fulfil the demands in accordance with article 10.1 and 10.3 of the EMC (Electro Magnetic Compatibility) directive 89/336/EEC.

All RM5yy cabinet versions are radio-proof in their basic design.

CE-marked Equipment

CE-marking of Avant Controller 160 implies some measures with respect to cabinets, mains supply filtering and handling of cable shields at the enclosure port. All to ensure conformity to the EMC-Directive 89/336/EEC. Please refer to Chapter 2, Installation, for more information.

According to information given in the ordering documentation, equipment shall be located in metallic or radio-proof cabinets (depending of product).

Open compartment is not permitted. Immunity against electromagnetic fields can generally be guaranteed with the cabinet containing metallic doors only.

Subrack Dimensions

The controller components are installed in a subrack in which you insert the S600 I/O modules too. Please refer to Section 2.2.14.2, Assembly for a description of different kinds of subracks.

Table 3-25. Controller Subrack Dimensions

Data	Value
Width	19 inches (482 mm)
Depth	325 mm
Height	269 mm(1)

(1) The cable duct RC610 adds a further 100 mm to the height. In order to insert and withdraw I/O modules, a minimum space of 120 mm above the subrack is required. You should also leave a space of 120 mm below the subrack for ventilation purposes.

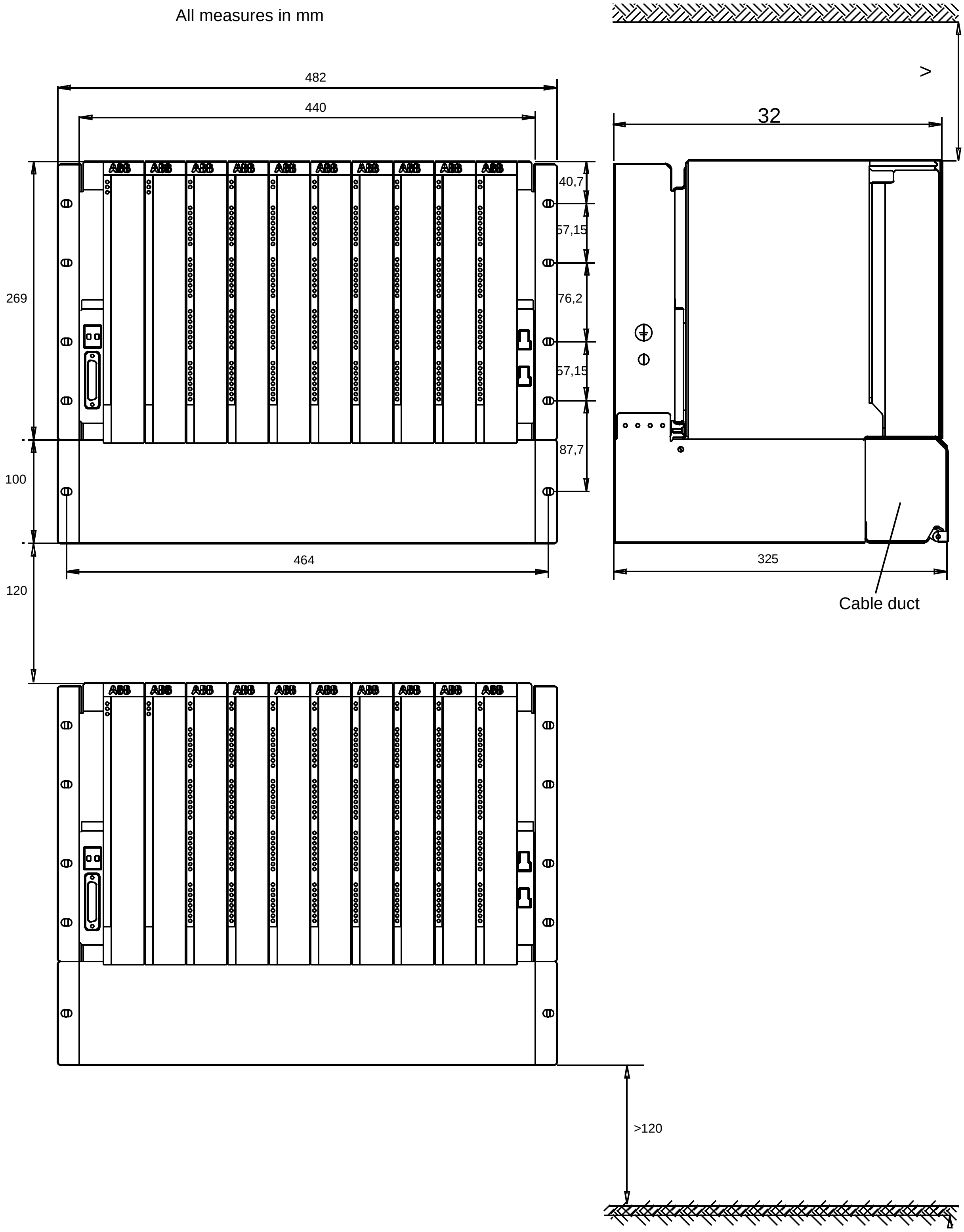


Figure 3-44. Controller Subrack and Cable Duct, Dimensions

Position disposition for the Basic Station

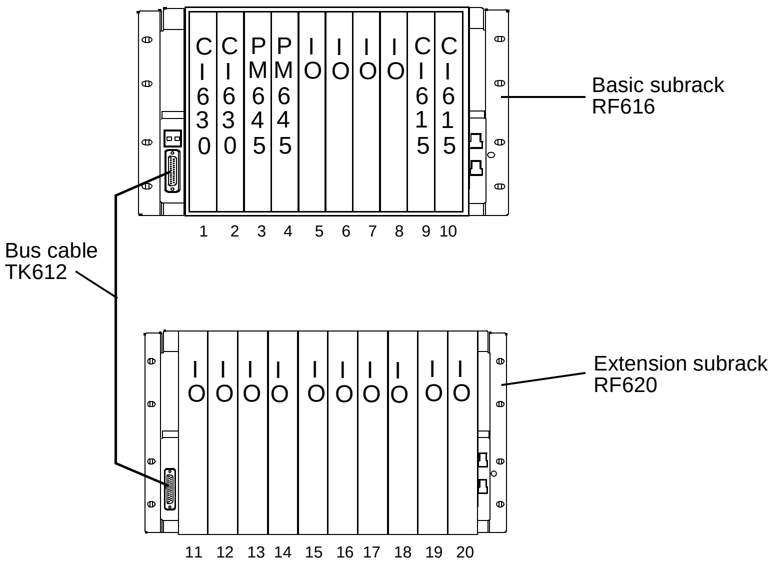


Figure 3-45. Basic Station, Example for Position Disposition

Table 3-26. Position Disposition for Basic Subrack in the Basic Station

Module	**Position**									
	1	2	3	4	5	6	7	8	9	10
PM640, PM644, PM645, PM646			max. 6 Processor Modules							
CI626		alt. for CI630							1 module alt. for 2 CI630 below	
CI627									1 module alt. for 2 CI631 below	
CI630	only for red.	mandatory							2 modules for red. second AF 100	
CI631									2 modules for red. second AF 100	
CI615			1 module mandatory for I/O expansion second module for redundant I/O expansion							
SC610			max. 1 module per controller							

Table 3-26. Position Disposition for Basic Subrack in the Basic Station (Continued)

Module	Position									
SA610									option: max. 2 modules	
I/O modules										

Position Disposition for the I/O Station

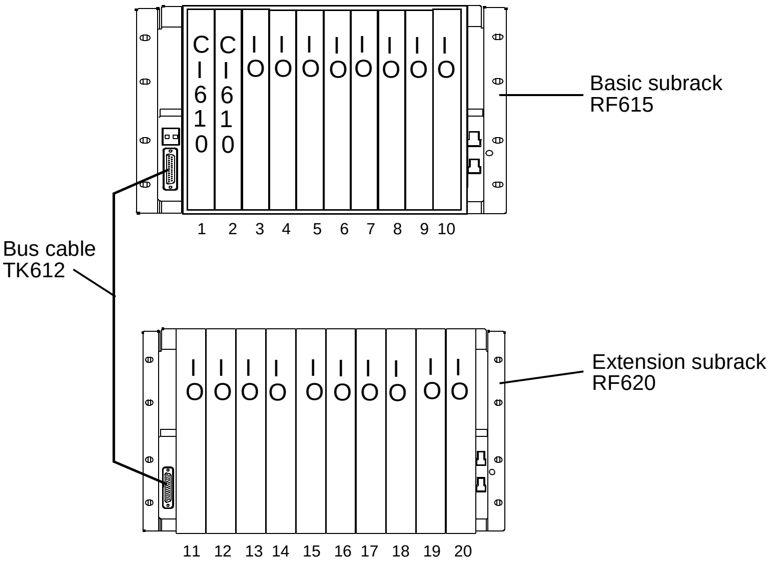


Figure 3-46. Basic Station, Position Disposition

Table 3-27. Position Disposition for Basic Subrack of the I/O Station

Module	Position									
	1	2	3	4	5	6	7	8	9	10
CI610	mandatory	only for red.								
SC610		max. 1 module per controller								
SA610									option: max. 2 modules	
I/O modules										

Table 3-28. Position Disposition for Extension Subrack of the Basic or I/O Station

Module	Position									
	11	12	13	14	15	16	17	18	19	20
SC610	max. 1 module per controller ▨	▨	▨	▨	▨					
SA610									option: max. 2 modules ▨	▨
I/O modules	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨

3.3 Database Configuration

For information on configuration and application building for Advant Controller 160, please refer to following documents.

- Instructions for the configuration and application programming of Advant Controller 160 systems.
  AMPL Configuration Advant Controller 100 Series Reference Manual.
- Data for all PC elements in Advant Controller 160.
  PC Elements Advant Controller 160 Reference Manual.
- Data for all Data Base elements in Advant Controller 160.
  Data Base Elements Advant Controller 160 Reference Manual.
- Basic manual covering the use of the application program language AMPL.
  AMPL Application Building Reference Manual.

3.4 Tutorial

The aim of this section is to give those who are inexperienced in this area a **short guide** through the different phases of a controller design project. There are methods and tools developed to make such project work effective in a variety of aspects. No references are made to methods and tools in this section because that is beyond the scope of this product manual.

Whenever possible, concrete references are made to suitable sections in this manual or to other documentation. The novice reader will preferably read completely Chapter 1, Introduction and Section 3.1, Considerations in this manual before starting the design work.

3.4.1 Introduction to the Design

The realization of a control system is normally based on a range of different documents. On the highest level, there are Plant Descriptions which give basic and general requirements like:

- Function
- Operation
- Safety
- Availability
- Maintenance.

Individual requirements on particular supporting processes like electric, instrument air, cooling, and so on, and particular sub-plants and sections are given in the Plant Design Documents. Here you can also find documents which are the basis of the control system design. Examples of such documents commonly used are:

- Function Descriptions (detailed)
- R&I diagram
- Instrument lists
- Motor lists
- I/O lists
- Applicable standards (plant, domestic, international).

3.4.2 Design Procedures

The following four main stages can be identified in the control system design procedure:

- **System Definition**
  Based on process control application analysis, a definition of the equipment must be made. The system definition phase is supported by this manual, especially Chapter 1, Introduction, which gives an overall introduction from the functional and available resources viewpoints and, of course, Section 3.1, Considerations. In addition, Section 3.2, Capacity and Performance gives some important information.
  The *ABB Master Product Guide* gives you an overview of the available product alternatives and possible options.
- **Configuration/Application Building**
  This phase is, to a certain extent, supported by the same chapters as the system definition phase. However, most information is available in separate reference documents as follows:
  - AMPL Configuration and Programming
  - PC Elements
  - DB Elements.

  Please refer to Section 1.5, Related Documentation for further document information.

- **Installation**
  During the design there are certain installation considerations to take care of, for example, the connection to the process.

3.4.2.1 System Definition

System definition in the actual context is a definition of the equipment required.
As a basis of the system definition, it is assumed that superior design stages have resulted in an overall application-functional identification of system components and structure. It is further assumed that a scheme of the functional distribution is available. Thus, a rough allocation of functions to different controllers is available.

Main points in the definition of a particular controller are:

- Type of controller to be used, reflecting
  - safety questions such as hazardous applications, emergency situations, abnormal operating situations, consequences in the event of a failure, behavior at start/stop, behavior at maintenance, manual control.
  - Processor Module performance
  - capacity requirements
  - reliability questions like availability, integrity
  - need for communication (need for physical interface).
- Type of I/O system
  Centralized or distributed location of I/O is normally determined at an earlier design stage reflecting such questions as maintenance, environment, economy (cable savings).
- I/O module assortment. Limitation in number of different types is often desirable.
- Physical interface to the process. Terminal blocks, marshalling, hazardous applications.
- Application of redundancy.
- Environmental questions. Special requirement of cabinets.
- Mechanical design, cabinet lay-out.

3.4.2.2 Configuration/Application Building

The next step is to make a detailed identification of functions and to design the application program based on AMPL. Finally, you implement the program.

To sum up, the main activities are:

- Circuit identification with respect to
  - Standard type circuits
  - User-defined type circuits
- Structuring
- Definition of functional interface to other system

- Execution control work-through
- Configuration/Implementation
  This is mostly an interactive session using an Engineering Station.

Some of these activities, sub activities and other similar subjects of interest are dealt with below.

Naming

All global objects are identified (and accessed) by unique names which you define within an application project. Certain objects are given default names by the system, which you can change later. From the system's point of view, the name structure is flat. However, since a name is a visible ASCII string, you can implement any kind of structure in naming objects.

Names are introduced in a controller via data base elements representing the actual object.
In general, the designation (connection NAME) on the data base element must be unique in the controller. Designations referred to from an operator station (for example AdvaSoft 2.0 for Windows NT) via a Control Network must also be unique in the total process control system connected by that network.

When defining signals, it is important that the signals be given names which are well considered and will not have to be changed at some later stage.

With auto-generation of a PC-diagram, the signal names are printed in the diagram. This is the reason for providing the signals with plain language names, even with a stand-alone controller.

The philosophy behind the naming of the signals should also be applied to calculated signals (for example DB elements AIC and DIC). As an example, the signal provided by a level transmitter is named LT 104.

The designation philosophy for objects in the process control system must be established when the signals are named (following relevant standards). The designations should preferably be hierarchic so that objects and signals are given associative names.

A feedback control loop for level control is an example (see Figure 3-47).
The actual value (the feedback signal) is suitably designated LT 104 (LT = Level Transmitter) and the controller output value LV 104 (LV = Level Valve). These names are obtained from one of the standards for designations in process industries, ISO 3511.

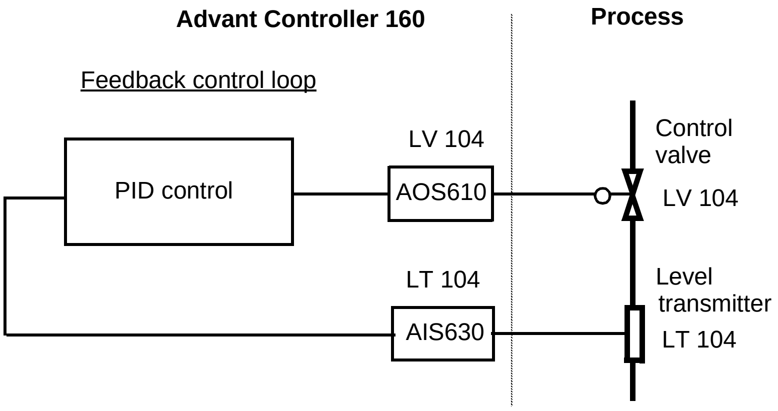


Figure 3-47. Example of Designations in a Feedback Control Loop

Application Building with AMPL

This phase is carefully supported by separate documentation as mentioned earlier. Some general notes and rules regarding application building and structuring are also given in Section 3.1.6.4, Guidelines for Application Building, where the subject is dealt with from other point of view.

Type Circuits

Type circuit building is a very important aid in the configuration procedure. A type circuit is a common collection of PC elements which can occur at several places in the application program.

A type circuit can be, for example, a certain type of feedback control loop or a panel control unit with push buttons and lamps. An advantage obtained by working with type circuits is that the work in designing the application program is reduced.

Instead of designing X number of program parts, one part is designed and used X times at different places, perhaps with the addition of a minor PC element for adaptation in certain cases.

When the function of a type circuit is thoroughly verified in one application, the commissioning of the remainder is much simpler. Another advantage is that the operator station functions based on type circuits become standardized.

Configuration/Implementation

This phase mainly comprises the interactive work carried out with the help of an Engineering Station, for example, Advant Station 100 connected to the target system. It is supported by separate documentation as well, mostly by the reference manual, *AMPL Configuration Advant Controller 100 Series Reference Manual*.

Chapter 4 Runtime Operation

4.1 Operating Overview

An Advant Controller 160 is an autonomous station which normally is not handled by an operator. Of course, it is started and sometimes stopped manually. This is done, however, in specific situations such as at the time of installation work and maintenance.

Accordingly, operating instructions are spread out in this manual. See where the specific activity is treated.

For general descriptions, see the following sections of this chapter. For concrete instructions, see Chapter 2, Installation and Chapter 5, Maintenance.

4.2 Operating Instructions

See the reference made in Section 4.1, Operating Overview.

4.3 Product Operation

4.3.1 Working Modes

A Processor Modules of Advant Controller 160 has the following two working modes: “OPERATION/DEBLOCKED” and “OPERATION/BLOCKED”.

The diagnostic indicator (LED display) on the Processor Module front indicates the working mode with the codes “P1” and “P3”, respectively.

- “P1”, working mode **OPERATION/DEBLOCKED**

  The Processor Module executes the application program. This is the normal status. The system can then perform control modules and control the process outputs.

- “P3”, working mode **OPERATION/BLOCKED**

  The Processor Module does not execute the application program (application is blocked). The process outputs keep their states. The state OPERATION/BLOCKED is—for redundant PM645A/B, PM646 if configured for redundancy—only possible if they are slave in the redundancy state TOOL.

The Processor Modules for redundancy—PM645A, PM645B and PM646—have two additional working modes “SLAVE/DEBLOCKED” and “SLAVE/FAILED”:

- “b1”, working mode **SLAVE/DEBLOCKED**:

  The Processor Module is slave within a redundancy configuration and executes the application program.

- “bF”, working mode **SLAVE/FAILED**

The Processor Module is slave within a redundancy configuration and is not ready for switchover (e.g., has failed without HALT or STOP).

During the boot phase and during the time of transition between working modes the display will indicate intermediate **system states.** These codes are relevant for fault finding and system analyses. These codes beside error codes are described below. Please see chapter 5 for the description of error codes.

Advant Controller 160 can contain up to six (6) Processor Modules.

Each Processor Module which is not involved in a redundant configuration (CPU or station redundancy) has its own working mode independent of the working modes of the other Processor Modules. Dependencies concerning the realized application programs are to be considered.

In case of a redundant configuration blocking of the involved Processor Modules is restricted. One Processor Module must remain unblocked, that is in case of dual redundancy only one Processor Module may be blocked, in case of triple redundancy two Processor Modules may be blocked. Anyhow, prior to blocking, the respective Processor Module must be entered in the redundancy mode TOOL. If only one Processor Module out of a redundant configuration is healthy it can be blocked too like a non redundant Processor Module.

4.3.2 Ordering Working Modes

You select working modes in either one of the following ways:

- Use a start mode.
- Use Advant Station 100 Series Engineering Station commands.

Please see the following sections.

4.3.3 Start Modes

In general, you can start an Advant Controller 160 in two different ways, as selected with the selector **Mode** on the Processor Module front.

The **Mode** selector has 2 positions.These are named STOP (Mode 0) and COLD START (Mode 1).

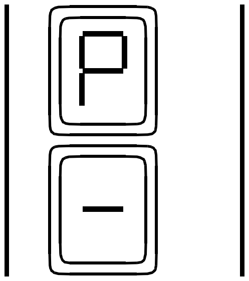
At first you select the start mode with the **Mode** selector and then press the **Res** button at the Processor Module. The system will restart according to the chosen start mode.

Table 4-1. Start Modes of the Processor Module.

Position	Function
STOP	The Processor Module does not start to execute the user application after pressing the **Res** button or after power up. User defined PC elements (Add-on options) are not installed in this mode.
COLD START	The Processor Module executes a cold start of the user application program after pressing the **Res** button or after power up. All variables are initialized.

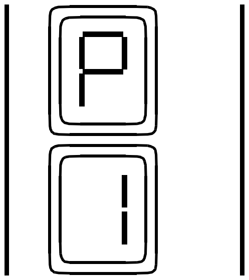
4.3.4 Relation between Start Modes and Working Modes

Using the **Mode** selector you can influence the working mode and (intermediate) system states of an Advant Controller 160 which are described below. These working modes and system states are indicated on the diagnostic display of the Processor Module which is comprised in an upper part and lower part in the following way:



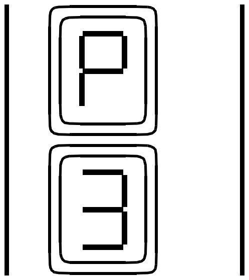
The Processor Module is in its initial phase.

(Display P- is independent from position of **Mode** selector)



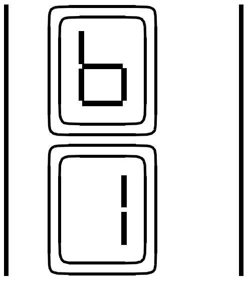
The Processor Module is in working mode OPERATION/DEBLOCKED.

Mode selector on position **COLD START**



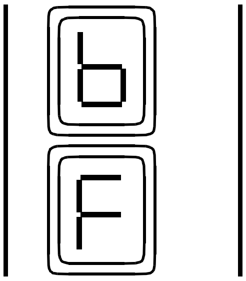
The Processor Module is in working mode OPERATION/BLOCKED.

The controller was blocked by Engineering Station **or** by **Mode** selector in **STOP** position after initialization.

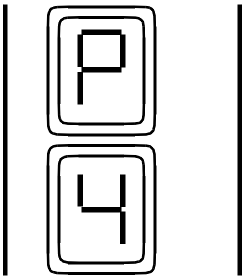


The Processor Module is in the redundancy state slave and executes the application program.

Figure 4-1. Example of Diagnostic Display Indicating System States

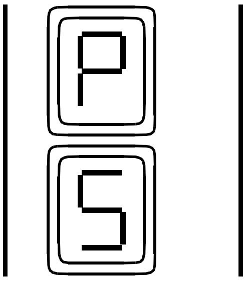


The Processor Module is in the redundancy state slave and is not ready for switchover (e.g. has failed without HALT or STOP).

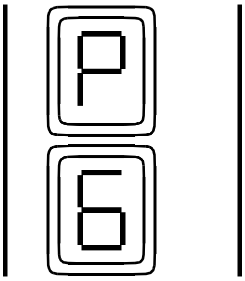


The Processor Module has no application program loaded.

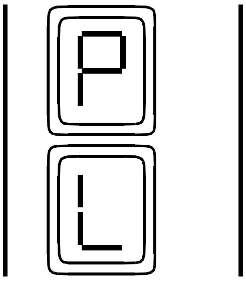
The controller is in working mode OPERATION.



The Processor Module is loading an application program from the internal PROM. **Mode** selector on position **COLD START**

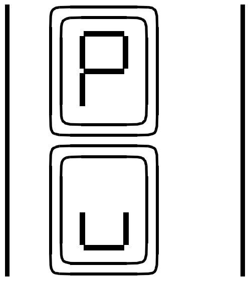


The Engineering Station is connected.
(Display P6 is independent from position of **Mode** selector)



Waiting for download of system software.
(Display PL is independent from position of **Mode** selector)

Figure 4-1. Example of Diagnostic Display Indicating System States (Continued)



Loading of system software option is in progress.
(Display PU is independent from position of **Mode** selector)

Figure 4-1. Example of Diagnostic Display Indicating System States (Continued)

4.3.5 Engineering Station Commands and Working Modes

The following Engineering Station commands order working mode transitions:

Function Chart Builder Command **Target | Block Program.**

Orders the controller from working mode OPERATION/DEBLOCKED to working mode OPERATION/BLOCKED.

Function Chart Builder Command **Target | Deblock Program**.

Orders the controller from working mode OPERATION/BLOCKED to working mode OPERATION/DEBLOCKED.

Function Chart Builder Command **Target | Restart**

To execute Function Chart Builder Command **Target | Restart** the controller must be ordered into working mode OPERATION/BLOCKED before.

Function Chart Builder Command **Target | Restart** orders the controller from working mode OPERATION/BLOCKED to system state COLD START.

If the MODE selector was in or COLD START position the controller will then be ordered to working mode OPERATION/DEBLOCKED.

If the MODE selector was in STOP position the controller will then be ordered to working mode OPERATION/BLOCKED and no application program will be loaded from internal flash PROM of the Processor Module.

4.3.6 System States

4.3.6.1 List of System States

The following table lists all the system states of the controller. They are indicated by the diagnostic display at the Processor Module. The working modes OPERATION/DEBLOCKED and OPERATION/BLOCKED corresponds to the system state OPERATION.

Table 4-2. List of System States Advant Controller 160

System State	**Description**	**Diagnostic Display**
Power Off	Advant Controller 160 has no power.	off
Booting	After power on, Advant Controller 160 starts with execution of the boot program. Then basic initialization starts. It decides according to MODE selector.	off
Cold Start	The Processor Module hardware and RAM is initialized (except a few variables which have to be preserved), the operating system is started and the tasks are created.	P-
OPERATION	The controller is operational. If an application program was loaded. It can be deblocked (working mode OPERATION/DEBLOCKED) or blocked (working mode OPERATION/BLOCKED).	P1, P3, P4, P5, P6
	The respective processor is slave deblocked (b1) respectively not ready for redundancy switchover (bF), e.g. failed without HALT or STOP. In state bF the error messages can be read through an Engineering Station using the diagnosis function of the Function Chart Builder (see Section 5.3.6, Faults Not Stopping the System).	b1,bF

Table 4-2. List of System States Advant Controller 160 (Continued)

System State	Description	Diagnostic Display
Halt	The controller is shut down. The process outputs are switched off. The coil of the run/alarm relay of the Processor Module is deactivated. Then, a minimum cold start is executed which only provides the communication to the engineering tool via serial interface at Processor Module or remote via AF 100 or RCOM (if configured).The diagnostic display of the Processor Module shows the error code. User defined PC elements (Add-on options) are not installed in this mode (because it could be the error reason). To recover from this state you can take **one** of the following measures: • press the RES button at the Processor Module • Switched off and on power • Execute Function Chart Builder Command **Target | Restart** at Engineering Station. This is also possible via RCOM or AF 100 (remote connection).	error code
Stop	The controller is shut down. The process outputs are switched off. The coil of the run/alarm relay of the Processor Module is deactivated. The diagnostic display of the Processor Module shows the error code. The red FAULT LED at the Processor Module is switched on. To recover from this state you can take **one** of the following measures: • press the RES button at the Processor Module • Switched off and on power	error code
Loading system software or options	New system software (BASE) or options (OPT) are being loaded.	--, PL, PU, then continue

4.3.7 System Software

This section contains just a brief description of the internal Advant Controller 160 software. For more information please refer to *AMPL Configuration Advant Controller 100 Series Reference Manual*.

4.3.7.1 Structure

The system software provides internal program functions and links together the application program with the system hardware.

Figure 4-2 presents the main parts of the Advant Controller 160 software.

The application programs are built-up and edited with an Engineering Station using the Function Chart Editor.

The execution of the executable units in the PC program is organized by the kernel of the Advant Controller 160 system software which also handles certain program amendments, primarily those performed during execution (on-line configuration and programming, value display and forcing, see Section 1.8.6.2, On-line Features.

Kernel

The PC program and the related control modules (the executable units) in an Advant Controller 160 must coexist with other types of programs such as diagnostic and communication programs. One task of the kernel is to schedule the execution of the different executable units.

The kernel schedules, at each point in time, the execution of the program with the highest priority. This may have the effect that the execution of an executable unit is interrupted temporarily by another executable unit. This, however, has no effect on the function of the PC program.

Communication

The communication part of the Advant Controller 160 system software supports the communication with the tools (Engineering Station), other controllers (for example Advant Controller 450) or Operator Stations (for example AdvaSoft 2.0 for Windows NT).

Diagnostic

The diagnostic program performs diagnosis of the Processor Module and all connected modules.
The diagnostic program writes error information into an error buffer. The error buffer can be read and deleted by means of an Engineering Station. Error terminals can be accessed by the application program.

Function Block Library

The function block library contains the execution code of PC elements and internal function blocks (for example functions for display and force of values, move blocks between data areas).

The software of the Advant Controller 160 systems is schematically illustrated below.

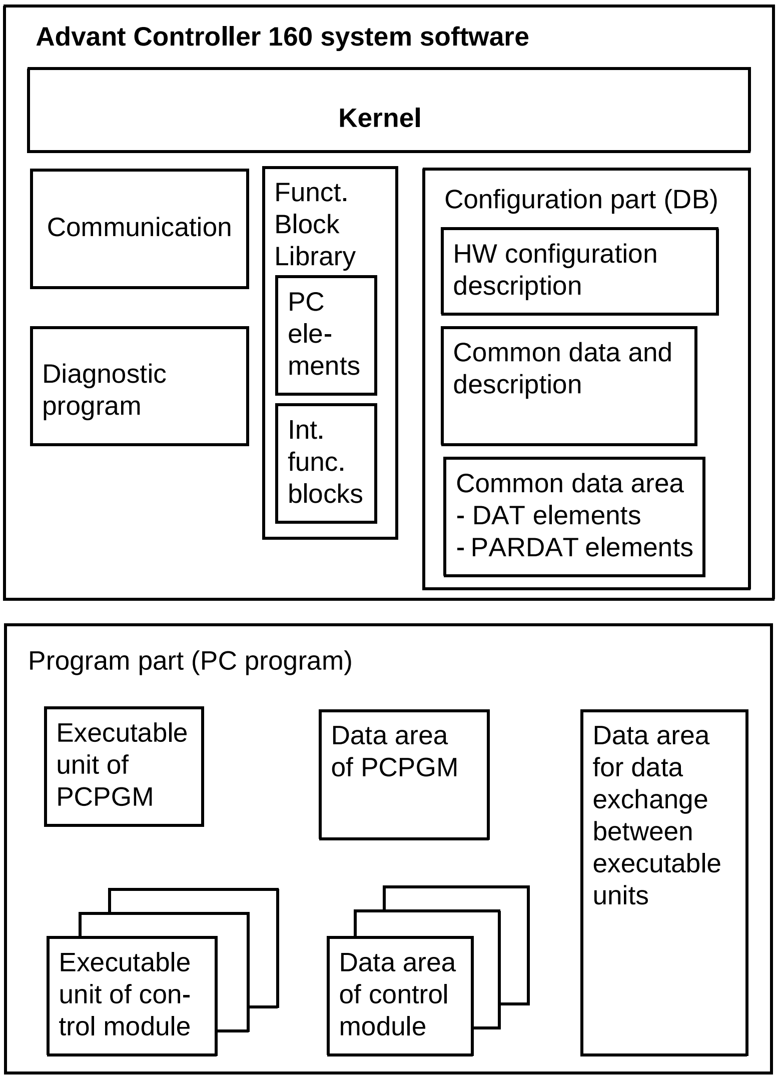

Advant Controller 160 system software
Kernel
Communication
Diagnostic program
Funct. Block Library
PC ele-ments
Int. func. blocks
Configuration part (DB)
HW configuration description
Common data and description
Common data area
- DAT elements
- PARDAT elements
Program part (PC program)
Executable unit of PCPGM
Data area of PCPGM
Data area for data exchange between executable units
Executable unit of con-trol module
Data area of control module

Figure 4-2. Block Diagram of Advant Controller 160 Software

4.3.7.2 Process Communication

Advant Controller 160 exchanges data with the process. This is performed directly via backplane-connected S600 I/O modules or S600 I/O modules in I/O stations.

Data for these I/O modules are stored in the following different data areas:

- Hardware configuration description area containing configuration data for the I/O modules and channels.
- Local data areas of PCPGM and of control modules containing process data.

Data transfer of configuration data to the I/O is performed during system initialization and for on-line exchanges after the download of new configuration data.

Data exchange between the process and the local data areas is performed directly by the related executable units within their input and output phases.

Input and Output Phases

To isolate each executable unit from data change during execution, the execution is commenced by an input phase and ends with an output phase.

This data exchange is performed by GET elements for the input phase and PUT elements for the output phase.

The PUT and GET elements are internal function blocks of Advant Controller 160.

PUT and GET elements are automatically inserted by the Engineering Stations.
They are indicated in the PC diagram by a "P" or a "G". Figure 3-21 shows you an example of the layout of a PC program with "P" and "G" indications.

Input

During the input phase of an executable unit, the used values are stored in the local data area of the executable unit. Sources of these data are the following:

- I/O and communication modules and channels.
- Common data area.
- Data area for data exchange between executable units.

Output

During the output phase, the calculated data from the PC elements in an executable unit are transferred to the following destinations:

- I/O and communication modules and channels.
- Common data area.
- Data area for data exchange between executable units.

The data is fetched directly from the storage location of each PC element output.

4.3.8 Application Program

The application program is written in a high-level language ABB Master Programming Language, AMPL. A user normally comes in contact only with AMPL and the specification of Data Base elements (DB elements).

The application program consists of a PC part and a DB part.

For more information please refer to *AMPL Configuration Advant Controller 100 Series Reference Manual*.

4.3.8.1 DB Part

The DB part in an Advant Controller 160 contain the DB elements which are used to configure Advant Controller 160.

DB elements in an Advant Controller 160 system describe the following items:

- The hardware of the Advant Controller 160 system (for example Processor Module, I/O modules and so on.)
- Communication Interfaces (for example MVICHAN, connection to AF 100 and so on.)
- Common data elements (for example DAT, PARDAT)
- Event handling.
- Connection between the hardware and the common data elements (DataSet Peripheral DSP).
- Extended DB elements covering a set of the previous items and HMI functions: AIS, DIS, AOS, DOS, MB, MBS, MI, MIL, and MR

See *Data Base Elements Advant Controller 160 Reference Manual* for detailed description of each Data Base element.

4.3.8.2 PC Part

The PC part of a user application program describes the control algorithm and the control strategy. It contains the required PC elements, their interconnections and the connections to the DB elements.

A PC program can be divided into several executable units, which consist of PC elements. Each executable unit can be given its own cycle time and its own execution conditions.

Figure 3-21 shows an example of the layout of a PC program.

PC elements are the smallest "building blocks" in a PC program. They are described in detail in *PC Elements Advant Controller 160 Reference Manual*.

4.3.8.3 Execution

Sequence of Execution of Executable Units

In certain applications, the order in which executable units are executed is of interest. Assume that an application is divided into executable unit which exchange data with each other and that these units have the same cycle time, see Figure 4-3. It is also assumed that executable unit 1 is required to execute before unit 2.

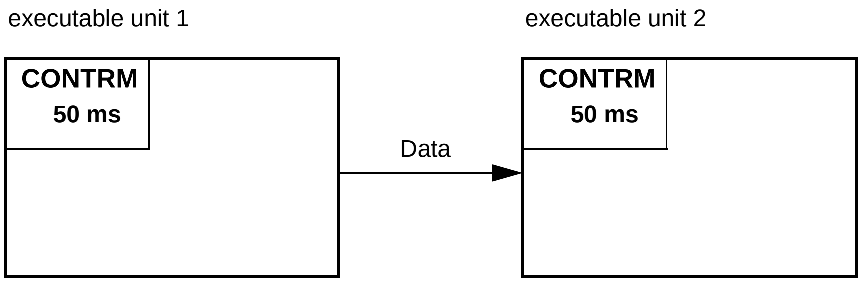


Figure 4-3. Function Consisting of Two Executable Units

When the conditions for an executable unit are defined, it is possible, with the call parameter "Place in the cycle table" of CONTRM, to specify a place number between 1 and 255. This place number specifies the order in which the executable units are executed during the same cycle time. If, in the example, the place number 1 is specified for the executable unit 1 and the place number 2 is specified for unit 2, the required function is obtained.

For executable units with different cycle times, there is no defined sequence. A required start sequence can, however, be obtained by controlling the start conditions for the executable units included.

Execution Sequence within an Executable Unit

Advant Controller 160 processes the different executable units in a certain order. The following examples shows the order for the PC program PCPGM and the executable unit CONTRM (for description of other executable units please refer to *AMPL Configuration Advant Controller 100 Series Reference Manual*):

- Processing of PC program (processing of PCPGM)
    a. Reading input values of the structure element PCPGM
    b. Processing structure element PCPGM
    c. Writing output values of the structure element PCPGM
    d. Transfer of common data between common data area and Advant Fieldbus 100 DataSet communication.

- Processing of control module CONTRM
  1. a. Reading input values of the structure element CONTRM
  2. b. Processing structure element CONTRM
  3. c. Writing output values of the structure element CONTRM
  4. d. Reading input values in the control module
  5. e. Processing elements in the control module
  6. f. Writing output values in the control module.

4.3.8.4 Execution Sequence of PC Elements

After execution of the function of a particular executable unit and after the reading-in phase for the control module (see section above describing CONTRM), the execution of the PC elements included begins. This is performed, element by element, in the order in which they are entered at program entry, which also corresponds to the order of documentation.

In the following example the elements are executed in accordance with the arrows. See Figure 4-4.

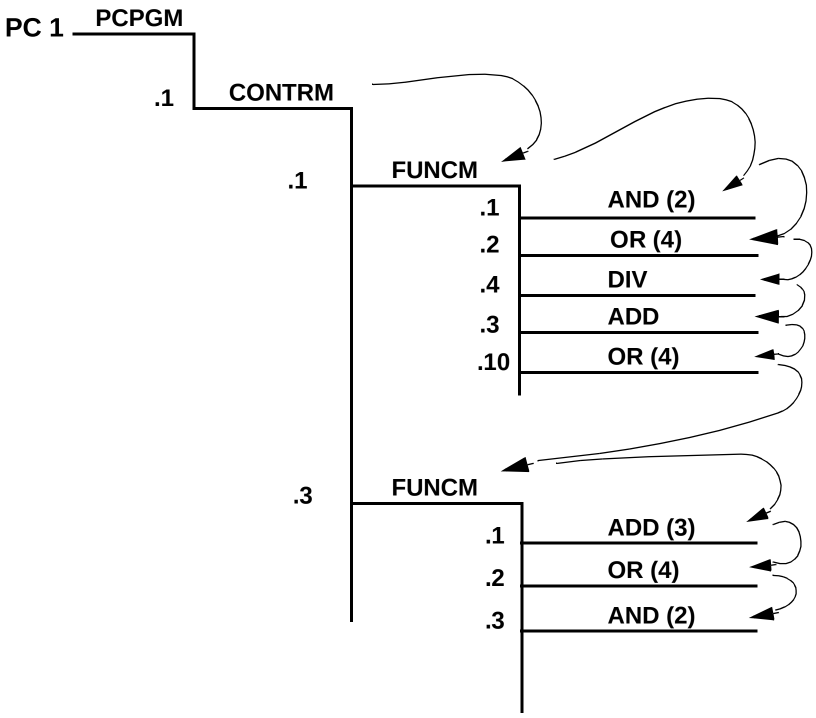


Figure 4-4. Printout of the Tree Diagram

Note that the item designations of the individual PC elements have no effect on the order of execution. The PC element DIV with item designation PC1.1.1.4 is thus executed before the PC element ADD, PC1.1.1.3.

4.3.8.5 Execution Sequence for an Individual PC Element

Execution of the PC elements commences after the execution of the header of an executable unit and the execution of the input elements.

The PC element itself controls its execution by calling the code in the element library for the next element. This is done in the order of storage, which also corresponds to the entry and documentation order.

The program code in the library works with a part of the PC program corresponding to a single element. The execution sequence within a PC element is illustrated in Figure 4-5 by an ADD-gate with two inputs.

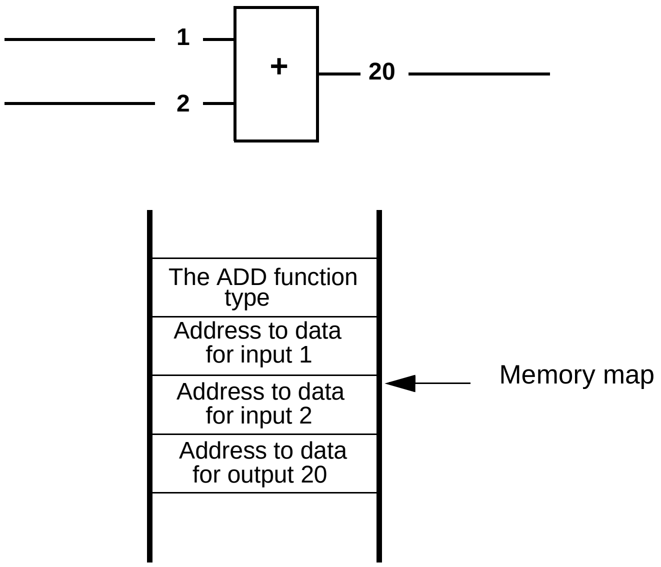

1
2
+
20
The ADD function type
Address to data for input 1
Address to data for input 2
Address to data for output 20
Memory map

Figure 4-5. Order of Execution for PC Elements, AND Gate with Two Inputs

The order of execution is:

- Previous PC element reads function type, in this case ADD, and calls the program code for this function from the element library.
- Current values at the storage places pointed out by inputs 1 and 2 are read from local data area of the executable unit. The arithmetic ADD-function is executed according to the program code ADD.
- The result is stored at the storage place specified for output 20 in the local data area of the executable unit.
- Then the current ADD program code reads the function type of the next element and calls the related element code to proceed with the next element in the PC program.

PC elements coded with in-line code are an exception. These elements are coded directly as processor instructions.

4.3.8.6 Reset Execution

Clearing or reset execution takes place when an R input of a module header is active. This has the effect of setting all variables in the local data area of the module to an initial value. For most variables, this implies that they are set to the zero value of their respective data type. (There are, however, certain exceptions to this, since the outputs of a certain element must have consistent value.) For more information please refer to *AMPL Configuration Advant Controller 100 Series Reference Manual.*

4.3.8.7 Scanning of Process Inputs

All analog and digital process inputs are scanned cyclically with the cycle time of the executable unit in which these inputs are consumed. See also Section 4.3.7.2, Process Communication.

4.3.8.8 Data Transport

Input Phase with GET Elements

Each execution of an executable unit begins with an input phase. This means that all PC elements in the executable unit have input data which is read on the same occasion. The way of associated data during the complete execution is illustrated with the example in Figure 4-6.

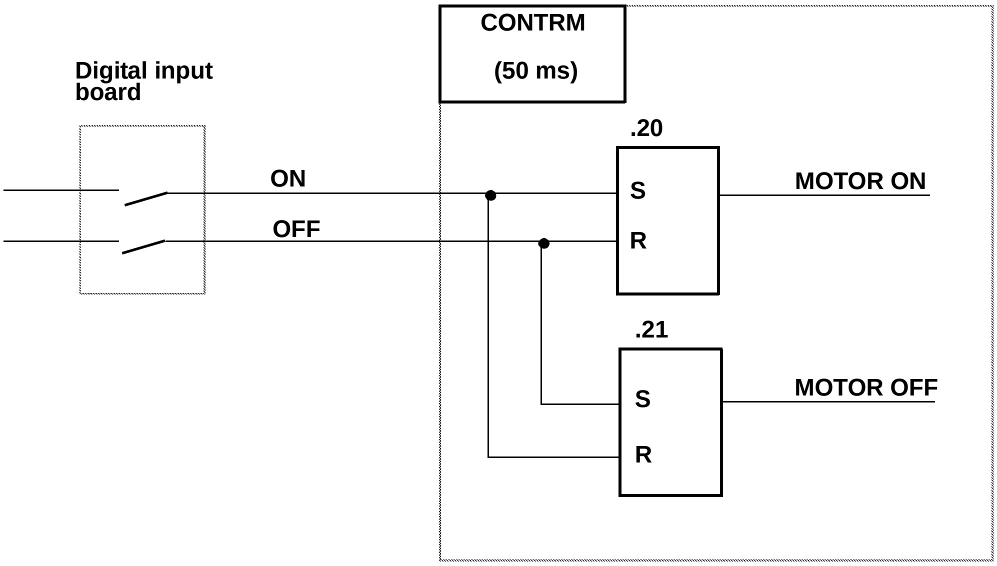


Figure 4-6. Example of Reading-in Phase

Assume that execution of element “.20” is followed by an interrupt and the digital input signal changing status from 1 to 0. When the execution is resumed with element “.21”, the signals MOTOR ON and MOTOR OFF are active simultaneously. The system automatically introduces a (“invisible”) GET which reads the values of the input signals at the beginning of the execution of the unit and stores them in the local data area to prevent such faults.

Output Phase with PUT Elements

The execution of all executable units is concluded with an output phase. This means that output data from the executable unit is obtained from the executions of all of the PC elements in the unit.

The following example illustrates the requirements for PUT elements. Assume two executable units with the cycle times 500 ms and 50 ms, respectively, see Figure 4-7.

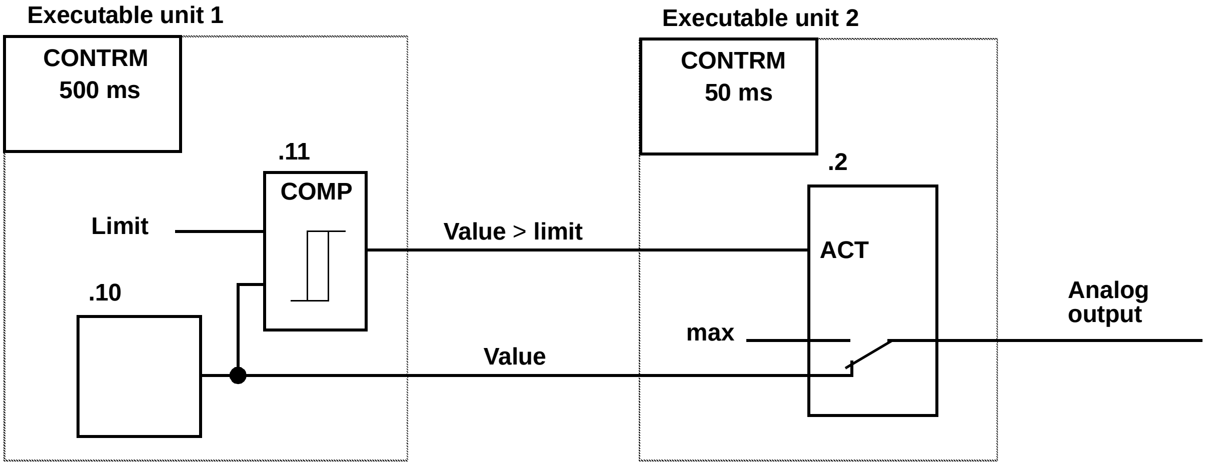


Figure 4-7. Example of Reading-out Phase

A value is calculated in the executable unit 1 with the cycle time 500 ms and a limit check is performed on the calculated value. These values (VALUE and VALUE > LIMIT) are connected to an executable unit with the cycle time 50 ms where the logical signal VALUE > LIMIT controls an analog output with a fixed value MAX or with the calculated signal VALUE. Assume that when element ".10" has been executed (but not ".11"), an interrupt signal with the cycle time 50 ms interrupts the executable unit 1. The PC element in this unit works with the values of the signals VALUE > LIMIT and VALUE, which are not associated with one another. To prevent this, the system automatically introduces an ("invisible") PUT element.

The purpose of the PUT element is to ensure that the output signals from an executable unit only become legible for PC elements within other executable units when all PC elements within the unit have been executed.

Data Transport Between Executable Units

The data transport to input and outputs which are represented by DB elements is executed by GET elements and PUT elements.

The data transport between executable units is organized in the same way. The output to a PC element of another executable unit uses a PUT element which writes to a data area for data exchange between executable units. The input of the other executable unit reads via GET element from the corresponding location in that data area. The Engineering Station automatically inserts the necessary PUT and GET elements which are "invisible". You just make a connection between PC elements independent whether they are part of the same executable unit or not.

Chapter 5 Maintenance

5.1 Preventive Maintenance

This chapter describes routine maintenance, replacement and installation procedures necessary to maintain the operation of an Advant Controller 160.

You can reduce future maintenance effort already during configuration and application building phase of your controller project. See Section 3.1.9, Module Types and Programming Style.

5.1.1 Safety Regulations

Always follow the instructions below when installing and operating an Advant Controller system to minimize the risks of injury to personnel and of damage to the equipment. Local statutory regulations, to the degree that they are stricter than the following, take precedence.

5.1.1.1 Personnel and Process Safety

DANGER – CAUTION

Observe the following:

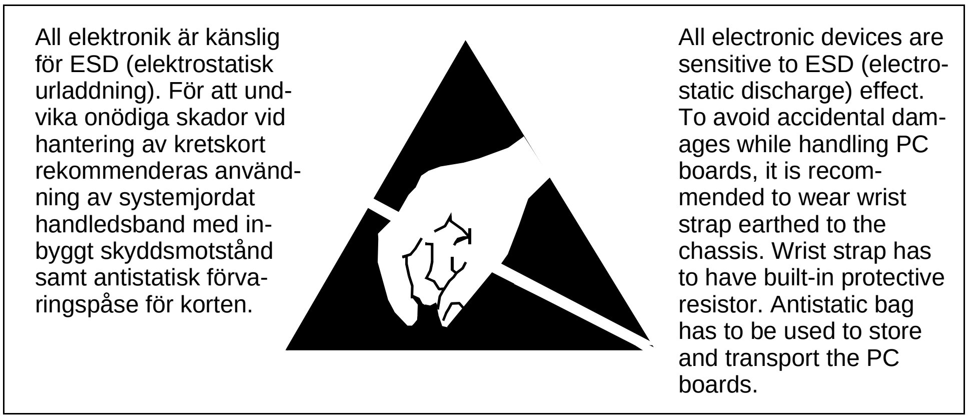
- Use only approved hoisting equipment when lifting cabinets. See lifting instructions enclosed with the cabinet.
- Never switch on the voltage supply of the cabinet during installation work. However replacement of modules in subracks can be done on line, that is while power supply is switched on. Special instructions are given for the work with power supply units.
- Power supply units in a “live” system, i.e while the mains supply is switched on, is to be **replaced by authorized service personnel only.**
- Work with care when supply voltage is applied in the system. The voltage in the cabinet can cause injury and can even kill a human being.
- Make sure that everyone working on the installation knows the location of the safety switch and the mains power supply switch to Advant Controller 160 equipment and how to use it.
- When the subsections of the process are checked and a test run has been performed, a responsible person is to check out interlocking chains, and so on.
- Inform all assembly personnel about test runs to be performed.
- Process technicians are to be present when testing and operating the process objects.
- Never press the **Res** (reset = initialization) button of the Processor Module if you do not know what happens in the system with an initialization.
- Remember that the control system can be controlled from an Engineering Station connected at another node via Advant Fieldbus 100. For example it can be stopped, configured and started remotely.
- Remember that an Advant Controller 160 starts automatically when voltage is applied. You can also prevent start-up of an Advant Controller 160 by setting the MODE selector in the STOP position.

5.1.1.2 Machine Safety

CAUTION

Observe the following safety rules:

- Avoid discharges of static electricity by grounding both yourself and tools before handling circuit boards and other parts of the equipment.
- Use the grounded wristband installed in the cabinet and the available folding working surface (service shelf) when handling parts of the system.
- Handle the modules carefully, particularly those which contain MOS components which can be damaged by static electricity discharges. Note the warning label on the modules.
- Use, as far as possible, the grounded wristband when handling modules not stored in envelopes of conductive plastic. This gives optimum protection against static electricity discharges.
- Always store modules in envelopes of conductive plastic when not installed in the system rack.
- Always switch off the voltage before extracting a module which cannot be exchanged while under voltage. Wait a sufficient time for the capacitors to discharge.
- Switch off voltage to the system and withdraw all boards at least 20 mm before electrical welding is performed near the controller system.
- A warning label is fixed in the system to draw attention to possible damage by ESD (Electro Static Discharge).



All elektronik är känslig för ESD (elektrostatisk urladdning). För att undvika onödiga skador vid hantering av kretskort rekommenderas användning av systemjordat handledsband med inbyggt skyddsmotstånd samt antistatisk förvaringspåse för korten.

All electronic devices are sensitive to ESD (electrostatic discharge) effect. To avoid accidental damages while handling PC boards, it is recommended to wear wrist strap earthed to the chassis. Wrist strap has to have built-in protective resistor. Antistatic bag has to be used to store and transport the PC boards.

Figure 5-1. Warning Label Regarding ESD

5.1.2 Visual Inspection

Inspect Advant Controller and the I/O cabinets at regular intervals determined by environmental factors such as vibration, air pollution, ambient temperatures, and so on.

5.1.3 Safety

Check that all screwed joints and connections within the cabinets are tightened effectively. Ensure that wiring, circuit boards and other electrical components are undamaged. Pay particular attention to overheating, damaged insulation or signs of wear.

5.1.4 Cleanliness

Remove dust and any other soil from the cabinet with a vacuum cleaner. Use a lint-free cloth, dampened with methylated spirits to remove stubborn dirt.

5.1.5 Air Filter

Wash the air filter included with the equipment in warm water with a mild detergent at regular intervals determined by environmental conditions. Replace the filter after three such washings. The new filter must be approved as a spare part.
Certain versions of cabinets include air filters. Please refer to the actual installation for further information.

5.1.6 Forced Cooling

If a fan is fitted, check its operation also.

5.2 Hardware Indicators

Most of the replaceable hardware modules are equipped with LED indicators.

- A green LED indicating running
- A red LED indicating fault
- A yellow LED indicating an active signal.

Some modules provide the additional yellow LEDs for increased maintainability, for example, send and receive information on communication modules.

The diagnostic display on the Processor Module indicates

- Processor Module status
- Halt codes in case of a severe fault including (partial) stop of the program.

You can find solid information along with the halt code, error message and fault finding descriptions in Section 5.3, Error Messages and Section 5.4, Fault Finding and User Repair below.

5.2.1 Indication on the Module Front of S600 I/O Modules

The meaning of the LED indicators of S600 I/O modules can be found in *S600 I/O Hardware Reference Manual* and *S600 I/O Hardware Advant Controller 160 Reference Manual*.

Between two and 34 LED indicators are located at the left-hand edge on the front of the modules. The two uppermost LEDs on all modules are FAULT and RUN. FAULT is a red LED indicating a module failure. RUN is a green LED and indicates that the module is configured and operating normally.

Digital input and output modules have a yellow LED for each channel to signal the status of the channel. The LED lights when the channel is “ON” (=1). The LEDs are located beside the fields with the channel numbers, making it easy to see the status of each channel.

RUN (Green LED):

The Advant Controller 160 system software checks that the modules are installed correctly and are not signaling a defect. A plausibility check of the following is performed during power-up:

- Module type
- Position
- Process connector on/off.

After the check is completed successfully, the RUN LED of the module is set.

FAULT (Red LED):

If a severe fault is detected by the I/O module itself, the FAULT LED on the front of the module lights and the internal input signals are set to “0”.

5.3 Error Messages

5.3.1 Fault Classification

Beside faults in the power supply system (see Section 5.5, Basic Fault Tracing) and faults which give no indication (see Section 5.6.1, Fault Tracing by Interpretation of Fault Symptoms) there are two main categories of faults in an Advant Controller 160 system:

- Severe faults stopping the system
  - Halt codes are shown on the diagnostic display on the Processor Module front
  - More detailed information can be read by an Engineering Station
  - Should the red LED FAULT on the Processor Module front be on, the Processor Module itself is most probably defective.
- Faults not stopping the system
  - Error information is accessible by an Engineering Station.

For both categories of faults (see Section 5.3.5, Faults Stopping the System and Section 5.3.6, Faults Not Stopping the System) you can read error messages by an Engineering Station using the Function Chart Builder command **Target | Diagnostics | Target | Report Errors**.

This command shows the error report of your Avant Controller 160 system. The error report lists the all detected errors with error type (see Section 5.3.3, Error Report).

Several kind of errors are grouped to a certain error type (see Section 5.3.2, Error Types). To get the specific error message *behind* an error type just make a double click on the error line.

The error message indicates significance and corrective action (see Table 5-1 and Table 5-2).

5.3.2 Error Types

Errors are classified into several types as listed in Table 5-1. The error type is used for both category of faults which stop or do not stop the system. The error type is shown in the error report (see Section 5.3.3, Error Report).

Table 5-1. Error Types Advant Controller 160

Type of Error	Significance
Application error	There is an error in your application program.
Communication error	An error occurred during communication.
Configuration failed	There is a mismatch between DB part of your application program and the hardware configuration of your controller system.
External hardware error	There is a hardware error outside of the Processor Module.
Fatal error	There is a fatal error. The corresponding module has to be exchanged.
High system load	The load generated by the running application is too high (warning).
Internal hardware error	There is a hardware error on the Processor Module.
Module is missing or not accessible	The module did not respond.
Module type does not match database	There is a difference in types between the I/O module on specified position in the station and that configured in DB part.
Power failure	Indicates that Advant Controller 160 was switched off or that there was a power failure.
Process error	The diagnosis detected a process error on specified I/O module.
Unknown error	The type of error is not known by the Advant Controller 160 system.
Start of application from PROM failed	There is an application in FPROM of the Processor Module which is incompatible to system software or software options.
System error	The Processor Module is not working correctly due to severe system software error during runtime.

Table 5-1. Error Types Advant Controller 160 (Continued)

Type of Error	Significance
System overload	The system is overloaded and stops. The load generated by the running application is too high.
Wrong firmware	Firmware on module is not supported.

5.3.3 Error Report

To get an error report of your Advant Controller 160 system you just connect an Engineering Station to the Processor Module and activate the Function Chart Builder command **Target | Diagnostics | Target | Report Errors**. (see Figure 5-2)

This command shows the error report of your Avant Controller 160 system. The error report indicates whether the system's diagnostic function has detected any fault or otherwise abnormal condition.

Apart from messages of non-fatal errors, such as I/O module errors, the error report also includes messages for errors which lead to a system stop.

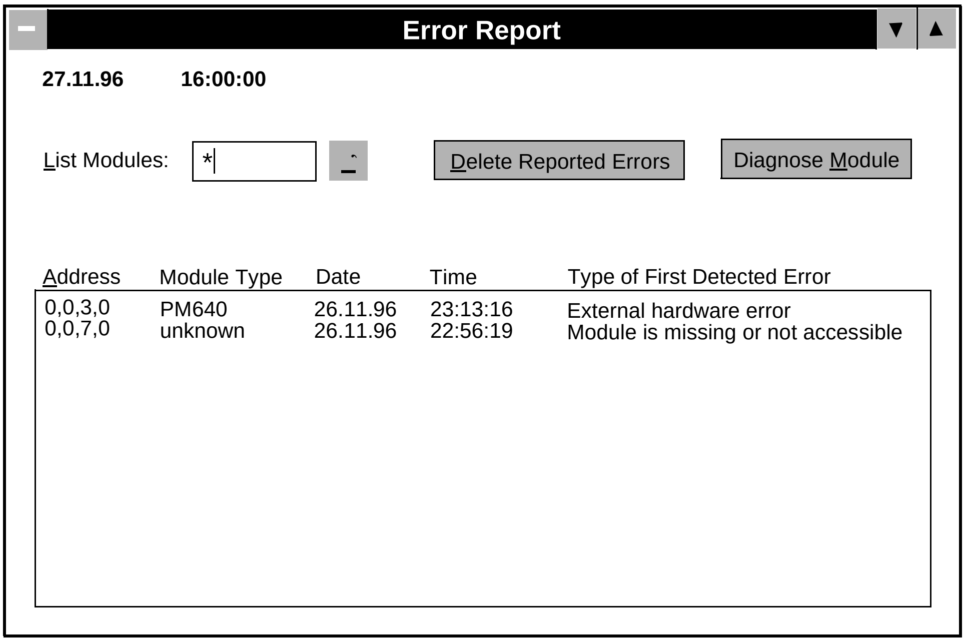
The error report shows the first occurred error if a module has several errors (see *First Detected Error* in Figure 5-2).

For tracing module or system errors, you can delete all reported errors by pressing button *Delete Reported Errors.* All errors will be deleted including those not shown because a module has several errors. Errors that are permanently present in the system are inserted again with an updated time stamp.

The error report lists the all detected errors with error type (see Section 5.3.2, Error Types).

Several kind of errors are grouped to a certain error type. To get the specific error message *behind* an error type just make a double click on the error line which activates the module diagnostic function (see Section 5.3.4, Module Diagnostic).

For more information about error report please refer to *AMPL Configuration Advant Controller 100 Series Reference Manual.*



27.11.96 **16:00:00**

List Modules: *

Address	Module Type	Date	Time	Type of First Detected Error
0,0,3,0	PM640	26.11.96	23:13:16	External hardware error
0,0,7,0	unknown	26.11.96	22:56:19	Module is missing or not accessible

Figure 5-2. Example for Report Error Window

Error reports generated by Advant Controller 160 have the following format (see also the figure above).

- Address: For I/O module errors the address of the related module is split in “bus”, “station,” “substation × 100 + position”, and “subposition”:

  bus
  Describes the bus number of the AF 100 to which the controller is connected.
  station
  Describes the station number (within Advant Fieldbus 100 control net) of the station in which the faulty module is placed.
  substation × 100 + position
  Substation describes the station number of the I/O station in which the faulty module is placed.
  Position describes the position number on which the faulty module is placed. (Example: substation = 3, Position = 18, substation × 100 + position = 318)
  subposition
  Describes the subposition of the faulty module (only displayed for SC610 and submodules, 0 = no submodule, 1 = submodule in upper subposition, 2 = submodule in lower subposition).

- Module Type: Module type, for example PM640
- Date: Date the error first occurred
- Time: Time the error first occurred
- Type of First Detected Error: Error type (see Section 5.3.2, Error Types).

  One error entry is reserved in the report per module, that is, the first error detected on this module is reported.

5.3.4 Module Diagnostic

When you choose the error report function by an Engineering Station using the Function Chart Builder command **Target | Diagnostics | Target | Report Errors** you get the module diagnostic function by a double click on the error line.

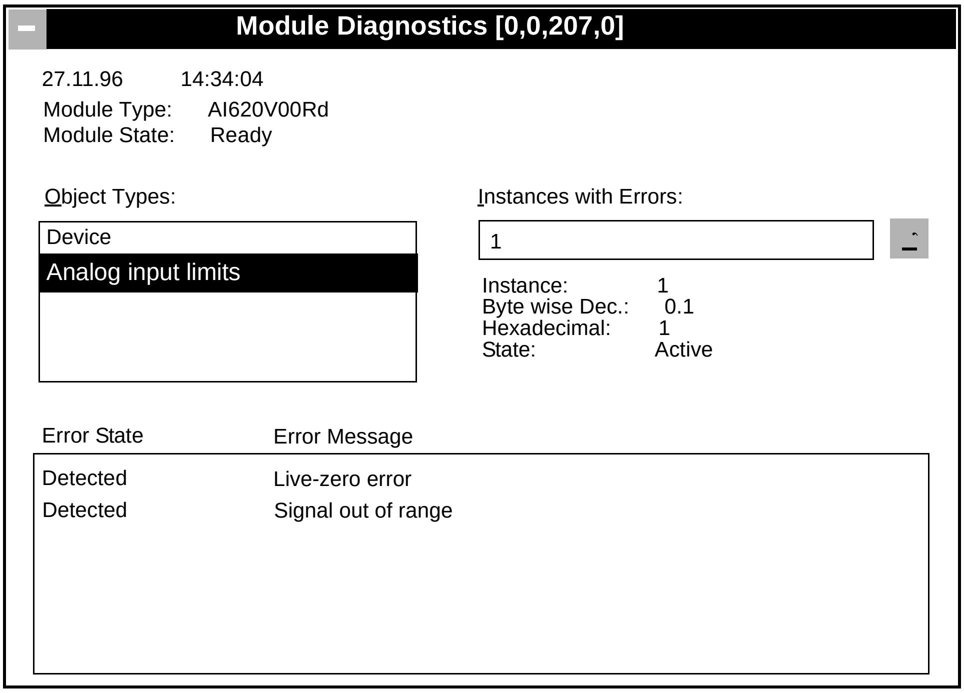
The module diagnostic function lists all the error messages and object types of the chosen module (see Figure 5-3). By default you get the error message of the device object.

Module objects are fictive items of the system software which are assigned to the module itself (for example device object, digital input channel object) or to Data Base elements (for example Data Set) or other parts of the system. Module objects will show you which parts of the system have a fault.

Error state of module diagnostics (see Figure 5-3) describes whether the error is still present or not. Error state can have 3 values:

Current	=	Error is still present.
Transient	=	Error was detected but is not present any more.
Detected	=	Error was detected but it is unknown whether error is still present.

For more information about module diagnostic please refer to *AMPL Configuration Advant Controller 100 Series Reference Manual*.



27.11.96 14:34:04
Module Type: AI620V00Rd
Module State: Ready

Object Types:
Device
Analog input limits

Instances with Errors: 1

Instance: 1
Byte wise Dec.: 0.1
Hexadecimal: 1
State: Active

Error State	Error Message
Detected	Live-zero error
Detected	Signal out of range

Figure 5-3. Example for Module Diagnostics of Device Object

Table 5-2. List of Module Object Types

Module objects	Comments
Device	–
Digital input channel	–
Digital input supervision	–
Digital output channel	–
Analog input channel	–
Analog input limits	–
Analog input register	–
Analog output channel	–
Analog output register	–
High speed counter	For pulse counter module
High speed counter 2	For pulse counter module
Bus extender	–
Data Set	–
MasterFieldbus master	–
MasterFieldbus slave	–
MVI channel	–
MVI node	–
MVI data block	–
Event handler	For SOE modules: DI65x, DI685
Event receiver	For SOE modules: DI65x, DI685
PROFIBUS-DP master	For PM644 PROFIBUS interface
PROFIBUS-DP slave	For Distributed Peripheral Modules

5.3.5 Faults Stopping the System

Faults which stop the system can be caused by a defective Processor Module.

In the case of a severe fault, which stops the Processor Module, a two-digit error code is presented on the Processor Module's diagnostic display. Should the LED FAULT light, the Processor Module itself is most probably defective.

Fatal errors are stored in the Processor Module and can be read by the Engineering Station using the error report function (see Section 5.3.3, Error Report).

The following table defines all error codes which are displayed as diagnostic display of the Processor Module, their names and their significance. It also gives hints on what action you should take.

If an error is marked with HALT, communication via serial interface of Processor Module to the Engineering Station is still working. Thus you can read the error report immediately by an Engineering Station using the Function Chart Builder command **Target | Diagnostics | Target | Report Errors**.

If an error is marked with STOP, communication via serial interface of Processor Module to Engineering Station is not working. Thus you should restart the system by pressing the RES button with MODE selector in STOP position to read the error report.

The error report shows the Type of Error. To get the specific error message *behind* an error type just make a double click on the error line. Then the module diagnostic of the Processor Module will appear. By default you get the error message of the device object which corresponds to the Processor Module.

Table 5-3. Error Codes on Diagnostic Display of Processor Module

Error code	STOP or HALT	Type of Error	Error message / Significance	Corrective action
01	HALT	Unknown error	Unknown error / The reason for this error is unknown.	Restart the system by pressing the RES push button with the MODE selector in COLD START position. Reload the application program and try again. Replace the Processor Module. Report error to support line.
05	HALT	Internal hardware error	Bus error in memory / The processor tried to access a nonexistent memory location. This indicates a serious system software error or defective hardware.	Restart the system by pressing the RES push button with the MODE selector in COLD START position. Replace the Processor Module.
06	HALT	Internal hardware error	BIM3 defect / This is a hardware problem.	Replace the Processor Module.

Table 5-3. Error Codes on Diagnostic Display of Processor Module (Continued)

Error code	STOP or HALT	Type of Error	Error message / Significance	Corrective action
09	HALT	Internal hardware error	Stall timer time-out / This is a software problem and indicates that the CPU is not working correctly. It is probably caused by a CPU overload.	Restart the system by pressing the RES push button with the MODE selector in the STOP position. Extend the cycle times of execution units in the PC program or remove one or more execution units, for example, control modules, and load and deblock the application again.
0A	STOP	Internal hardware error	RAM fault / The error code appears during the RAM test.	Replace the Processor Module.
0C	STOP	Internal hardware error	CPU instruction set fault/ This is a hardware problem.	Replace the Processor Module.
0D	STOP	Internal hardware error	Timer fault / This is a hardware problem.	Replace the Processor Module.
0E	STOP	Internal hardware error	Voter defective or Processor Module without voter.	Replace the Processor Module, use PM645A, PM645B, or PM646.
1A	HALT	External hardware error	Global memory not available.	Check if at least one Communication Interface CI630, CI631, CI626, or CI627 is plugged in slot 2. Check if AF 100 cable respectively at least the respective terminator is connected. Replace the Communication Interface if defective.
26	HALT	Start of application from PROM failed	Wrong configuration data of Processor Module / The Processor Module could not start the application due to unknown configuration data.	Check your application program for correct configuration data: • Correct Processor Module DB element? • Correct Slot no, Station no, bus no? • Correct Advant Fieldbus 100 DB element? • Correct CPU number at the redundancy address switch? • Same station number at the Processor Module DB element and at the thumb wheel of the basic station?

Table 5-3. Error Codes on Diagnostic Display of Processor Module (Continued)

Error code	STOP or HALT	Type of Error	Error message / Significance	Corrective action
27	HALT	Application error	Not enough memory for application available / The Processor Module could not start the application due to lack of memory.	Restart the system by pressing the RES push button with the MODE selector in STOP position. Then remove all loaded but unused options which may consume memory by loading BASE software. Enable only necessary options and restart the system by pressing the RES push button with the MODE selector in COLD START position. Reduce size of application. Avoid on-line changes on Processor Module.
42	HALT	System overload	System overload / The Processor Module was not able to run the specified control module. The control module could not be completed within the specified cycle time and was aborted.	Restart the system by pressing the RES push button with the MODE selector in STOP position. Then reduce the load by extending the cycle times, for example, of control modules in the PC program or remove one or more execution units, for example, control modules. Load and deblock the application again. Avoid on-line changes on Processor Module.
44	STOP	Internal hardware error	System PROM fault / This indicates that the memory used for storing the system software could be defective.	Reload the system software and try again. Replace the Processor Module.
46	STOP	Internal hardware error	Serial communication device defect / This is a hardware problem.	Replace the Processor Module.
49	HALT	System error	System error / Indicates an unexpected state, usually due to a system error.	Restart the system by pressing the RES push button with the MODE selector in COLD START position. Reload the application program and try again. Replace the Processor Module. Report error to support line if above measures do not help.

Table 5-3. Error Codes on Diagnostic Display of Processor Module (Continued)

Error code	**STOP or HALT**	**Type of Error**	**Error message / Significance**	**Corrective action**
4C	HALT	System error	CPU address error / This is a software problem and indicates that the CPU is not working correctly.	Restart the system by pressing the RES push button with the MODE selector in COLD START position. Reload the system software. Replace the Processor Module.
4D	HALT	System error	CPU exception / This is a software problem and indicates that the CPU is not working correctly.	Restart the system by pressing the RES push button with the MODE selector in COLD START position. Reload the system software. Replace the Processor Module.
51	HALT	Application error	Unknown function block called / Indicates that a function block (that is, PC element or DB element) has been called which the current system software does not recognize.	Load the correct system software or change the application program to match current system software.
54	HALT	Internal hardware error	OSP watchdog occurred / Indicates that I/O modules could not be accessed for a certain period and that the outputs were set to safe position (usually to "0").	Restart the system by pressing the RES push button with the MODE selector in COLD START position. Reload the application program. Replace the Processor Module.
5D	HALT	Start of application from PROM failed	Incompatible application in PROM / This may occur after loading of a new system software.	Restart the system by pressing the RES push button with the MODE selector in STOP position. Then generate new target code with a matching release of Advant Station 100 Series Engineering Station, download to Processor and save it in PROM.
5E	HALT	Application error	Add-on option installation incomplete / Add-on option is faulty.	Correct your add-on option and load again.

Table 5-3. Error Codes on Diagnostic Display of Processor Module (Continued)

Error code	STOP or HALT	Type of Error	Error message / Significance	Corrective action
5F	HALT	Start of application from PROM failed	Error in extended DB elements / Application with extended DB elements does not run.	Restart the system by pressing the RES push button with the MODE selector in COLD START position. Load your application again. Report this error to support line.
63	HALT	Start of application from PROM failed	Missing option(s) / Indicates that the application in PROM needs an option that is not part of the system software (probably due to download of new BASE system software).	Restart the system by pressing the RES push button with the MODE selector in STOP position. Then install the missing option and restart the system with the MODE selector in COLD START position.
67	HALT	System error	Protection watchdog responded / The triggering of the watchdog was interrupted or doesn't match the trigger window.This indicates a serious system software error or defective hardware.	Check other error messages which may have occurred a short time before. Replace the Processor Module PM646. Report this error to support line.
68	HALT	Internal hardware error	Protection watchdog - test failure / The error appears during the watchdog test, which is performed cyclically.	Replace the Processor Module PM646.
69	HALT	System error	Time-out of CRC monitoring / Indicates that the background checks of CRC's couldn't finished within the admissible time.This indicates a serious system software error. It is probably caused by a CPU overload.	Restart the system by pressing the RES push button with the MODE selector in STOP position. Extend the cycle times of execution units in the PC program or remove one or more execution units, for example, control modules, and load and deblock the application again.

Table 5-3. Error Codes on Diagnostic Display of Processor Module (Continued)

Error code	STOP or HALT	Type of Error	Error message / Significance	Corrective action
6A	HALT	System error	Life signal failure / There is a missing life signal detected from the counterpart CPU. Indicates a serious system software error or defective hardware.	Restart the system by pressing the RES push button with the MODE selector in COLD START position. Replace the Processor Module PM645/PM646. Report this error to support line.
6B	HALT	Communication error	Time-out of HSL sending data / The sending request wasn't terminated within the designated time.	Replace the Processor Module PM645/PM646. Report this error to support line.
6C	HALT	External hardware error	HSL cabling error / Wrong HSL cable connection or wrong CPU-No. concerning the redundancy configuration	Check all HSL cabling to the counterpart Processor Modules and the setting of the CPU-Nr. selector.
6D	HALT	System error	Software error, invalid default case / This is a software problem and indicates corrupted system data.	Restart the system by pressing the RES push button with the MODE selector in COLD START position. Report this error to support line.
6E	HALT	Internal hardware error	HSL sending channel disturbed (CS) / Defective sending hardware.	Replace the Processor Module PM645/PM646.
6F	HALT	Internal hardware error	HSL receiving channel 1 disturbed (CS) / Defective receiver hardware.	Replace the Processor Module PM645/PM646.
70	HALT	Internal hardware error	HSL receiving channel 2 disturbed (CS) / Defective receiver hardware.	Replace the Processor Module PM645/PM646.
71	HALT	System error	Version mismatch PS-CS/ Incompatible system software loaded.	Load a matching set of system software to processing (PS) / communication section (CS) of PM645/PM646. First start with the communication section.

5.3.6 Faults Not Stopping the System

A list of errors that do not lead to a system stop is shown in the table below. This list contains the possible error messages and actions to take to correct those faults.

You can read the error report by an Engineering Station using the Function Chart Builder command **Target | Diagnostics | Target | Report Errors**.

The error report shows the Type of Error. To get the specific error message *behind* an error type just make a double click on the error line. Then the module diagnostic of the Processor Module will appear.

By default you get the error message of the device object which corresponds to the Processor Module. To get the error message of another object just click to that other object.

Table 5-4. Error Texts in Error Report

Type of error	Error message / Significance	Corrective action
Application error	Add-on option installation incomplete / An Add-on option could not be installed during start up of Processor Module due to its system requirements.	Reduce the amount of installed Add-on options.
Application error	Event queue overflow in EVS / The event queue of an Event Set EVS(S) or EVS(T) has overflowed.	Check why events are generated faster than they are transferred to the event receiver. An extended event queue (terminal QUEUE=EXTENDED) may help.
Application error	Event receiver error in EVS / An Event Set EVS(R) or EVS(T) located on another station in the network requested events from a local Event Set.	Check the configuration of all EVS(T) and EVS(R) in the network (AF 100 or RCOM).
Application error	Event source error in EVS / An Event Set EVS(S) or EVS(T) has received events from an event source which is not referenced by this Event Set.	This error may occur after changes in the Event Set configuration. In that case, ignore this message, otherwise report to support line.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	**Error message / Significance**	**Corrective action**
Application error	Wrong AF 100 station address in application / A difference between station address on station address selector at base station subrack and that in configuration data was detected.	Select the same station address in the Engineering Station.
Application error	Memory allocation failed / Too much historical values for unplanned tracking. Both CPUs enter redundancy state Defective.	Check the application program for exceeding the maximum number of historical values per executable unit and per Processor Module. Reduce size of application program for the affected executable unit respectively Processor Module.
Configuration failed	Access of Communication Interface failed / The AF 100 Communication Interface could not be initialized and is in a faulty state.	Check bus connections and termination of Communication Interface. Exchange the Communication Interface.
Configuration failed	Finish of configuration failed / It was not possible to write configuration data to the specified I/O module or to save them therein.	Load application again. Exchange the specified I/O module.
Configuration failed	Module configuration failed / An error occurred during configuration of specified I/O module.	Check the specified I/O module and all its process connections. Check configuration data in DB part. Exchange I/O module.
Configuration failed	Passive module detected/ The diagnosis detected a passive I/O module.	Check process connections to all channels. Exchange I/O module.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	Error message / Significance	Corrective action
Configuration failed	Protocol type not supported / The type specified at MVICHAN DB element is not supported by MVI.	Use MVI that supports that protocol type. Specify protocol type at MVICHAN DB element that is supported by MVI.
Configuration failed	Read access to module failed / Internal error: It was not possible to read addresses from specified I/O module (only CI626, CI627, CI630, and CI631) - communication cannot be started.	For CI626, CI627, CI630, CI631: Delete error buffer—if this error occurs again, check Communication Interface itself and load on AF 100 and its configuration.
Configuration failed	Read module parameter failed / Internal error: Configuration data could not be read from specified module.	Exchange the specified I/O module.
Configuration failed	Read signal parameter failed / Internal error: It was not possible to access data from specified I/O module.	Exchange the specified I/O module.
Configuration failed	Start of configuration failed / The I/O module did not respond when starting the configuration.	Exchange the specified I/O module.
Configuration failed	Write module parameter failed / Configuration data could not be written to specified I/O module.	Validate correct configuration data in DB part. Check process connections to all channels of I/O module. Load application again. Exchange I/O module.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	Error message / Significance	Corrective action
Configuration failed	Write signal parameter failed / Configuration data could not be written to at least one channel of specified I/O module.	Validate correct configuration data in DB part. Check process connections to all channels of I/O module. Load application again. Exchange I/O module.
Configuration failed	Configuration failed / High load on BIOB.	Check green RUN LEDs of the I/O and interface modules. Delete reported errors via Tool. Check the configured cycle times, increase the cycle times.
Configuration failed	Maximum number of DSPs exceeded / The sum of configured DSPs of one AF 100 within all Processor Modules of the controller is higher than 400. The configured DSPs until 400 are still configured within the Communication Interface CI626 or CI630 but cannot be used by the Processor Module.	Check if more than 400 DSPs are configured for one AF 100 within all Processor Modules of the controller together. Reduce the number of DSPs under the limit of 400.
Configuration failed	PC element TRAC is essential / TRAC is missing. Affected CPU is in redundancy state Defective. Loss of 1 of 3 controllers with resulting reduced redundancy degree.	Check the application program concerning PC element TRAC.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	Error message / Significance	Corrective action
Configuration failed	Analog signal is outside the limit of the TRAC element / Tracking was not successful. The controller is not any longer involved in the redundancy.	Check the PC element TRAC concerning configured limits for tracking or activate the dynamic adaptation of the limits or replace the Processor Module (undetected error).
Configuration failed	Redundancy task was not activated / Redundancy doesn't operate	Check cycle time of the executable units (CONTRM and so on). Cycle time shall be ≥ 20 ms.
Configuration failed	Time-out of tracking procedure / Tracking not successful within the specified time. CPU entered the redundancy state Defective. Loss of 1 of 3 controllers with resulting reduced redundancy degree	Check configuration of the TRAC element: limits, limit adaptation parameters or check input values from input and interface modules, they must be identical for all involved Processor Modules or check the modules of the affected controller.
External hardware error	Bus error while module access / The CPU can not access the backplane bus.	If this error happens often replace Processor Module.
External hardware error	Field cabling missing or defective redundancy / CPU entered the redundancy state Defective. Loss of 1 of 3 controllers with resulting reduced redundancy degree.	Check cabling and selector switches 89AU31 and 89AL31.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	Error message / Significance	Corrective action
External hardware error	High speed link channel 1 time-out detected / Data transmission via HSL not operational. If used for redundancy the slave entered the redundancy state Defective.	Check cabling and partner Processor Modules.
External hardware error	High speed link channel 2 time-out detected / Data transmission via HSL not operational. If used for redundancy the slave entered the redundancy state Defective.	Check cabling and partner Processor Modules.
External hardware error	High speed link channel 1 CRC error detected / Data transmission via HSL not operational. If used for redundancy the slave entered the redundancy state Defective.	Check shielding of the HSL cables.
External hardware error	High speed link channel 2 CRC error detected / Data transmission via HSL not operational. If used for redundancy the slave entered the redundancy state Defective.	Check shielding of the HSL cables.
External hardware error	Voter disabled due to defective latch / Loss of one of 2 (3) Voters	Check cabling or check the Voter (see Section 5.6.2, Voter Test).

Table 5-4. Error Texts in Error Report (Continued)

Type of error	Error message / Significance	Corrective action
External hardware error	High speed link line is disturbed / Data transmission via HSL not operational. If used for redundancy the slave entered the redundancy state Defective.	Look for further messages using module diagnosis for Processor Modules.
External hardware error	Open links to redundancy detected: "master" / Processor Module cannot be tracked by the master. The Processor Module entered the redundancy state Defective.	Check cabling.
External hardware error	Open links to redundancy detected: "slave" - Processor Module cannot track the slave. The slave (not the reporting Processor Module) entered the redundancy state Defective.	Check cabling.
Fatal error	Fatal error / The specified I/O module has a fatal device error.	Exchange I/O module.
High system load	System high load / The load generated by the running application is too high. Danger of overload.	Reduce the load.
Internal hardware error	Application PROM fault / This indicates that the memory used for storing the application program could be defective.	Restart the system by pressing the RES push button with the MODE selector in STOP position. Then reload the application program and try to save it again in PROM. Replace the Processor Module.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	**Error message / Significance**	**Corrective action**
Internal hardware error	Real-time clock defect / The real-time clock of the Processor Module is defect.	Replace the Processor Module.
Internal hardware error	Voter disabled due to missing master / Voter didn't select a master, loss of one of 2 (3) voters	Check cabling or check the Voter (see Section 5.6.2, Voter Test).
Internal hardware error	Voter disabled due to more than one master existing / Voter selected more than one master, loss of one of 2 (3) voters	Check cabling or check the Voter (see Section 5.6.2, Voter Test).
Internal hardware error	Communication controller defective / All HSL's of the Processor Module defective. If used for redundancy the slave entered the redundancy state Defective.	Replace PM645/PM646.
Internal hardware error	Redundancy state "Defective" caused by input SKIP / The redundancy partners voted the master out because of inadmissible deviation. Loss of one of 3 controllers.	Check configuration of the TRAC element: limits, limit adaptation parameters or check input values from input and interface modules, they must be identical for all involved Processor Modules or check the modules of the affected controller.
Internal hardware error	Failure of module's binary I/O port.	Check cabling or replace PM645/PM646.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	Error message / Significance	Corrective action
Module is missing or not accessible	Module is missing or not accessible / The module did not respond.	Insert or exchange module.
Module type does not match database	Module type does not match database / There is a difference in types between the I/O module on specified position in the station and that configured in DB part.	Use the same type in station and in DB part.
Power failure	Power failure / Indicates that Advant Controller 160 was switched off or that there was a power failure (complete base station or extension subrack of base station).	Check the power supply to the extension subrack of the base station.
Process error	Process error / The diagnosis detected a process error on specified I/O module.	Check process connections to each channel. Validate configuration data for the I/O module and configured channels. Exchange I/O module.
System restarted	System restarted / The CPU performed a restart due to an error or by external command (for example RCOM cold start command).	Check other error messages which may have occurred a short time before. Check the reason for extern restart command.
System error	Activating channel failed / It was not possible to activate an I/O channel during configuration or diagnosis.	Check process connections to all module channels and validate configuration data. Exchange I/O module.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	**Error message / Significance**	**Corrective action**
System error	Activating module failed / It was not possible to activate the I/O module itself (green RUN LED is probably off).	Check process connections and power supply for specified I/O module. Exchange I/O module.
System error	Write state control failed / It was not possible to activate, passivate or to delete a channel of the specified I/O module.	Load application again. Exchange I/O module.
System error	Passivating channel failed / Internal error: it was not possible to passivate unused channels.	Ignore this message if the I/O device has been reported as a defective module previously and exchange that module if it is to be used further on. Otherwise, report this error to support line.
System error	Passivating module failed / Internal error: it was not possible to passivate the I/O module.	Ignore this message if the I/O device has been reported as a defective module previously and exchange that module if it is to be used further on. Otherwise, report this error to support line.
System error	System error / The diagnosis detected a system error on I/O module.	Check process connections of I/O module and configuration data in DB part. Read further diagnosis data with diagnosis tool.
Unknown error	Unknown I/O module error ## / An unknown error was detected on I/O module.	Report this error to support line.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	Error message / Significance	Corrective action
System error	Activation of the Second Shutdown Path / Fault reaction after responding of different monitoring functions of PM646: - User defined respond. - Block of the application - Error of DX610 - Time-limited 1oo2 configuration expired.	Check Error Report for previous entries causing this error. Ignore after blocking of the application program or Check for faulty module DX610 or Startup 2oo3 configuration again.
System error	Deactivation of the Second Shutdown Path / Reported after taking back of the activation.	None.
Communication error	HSL channel 1 - time-out of user data (CS) / Receive time-out of planned tracking data.	Check connecting link of HSL channel 1 for transmitting planned tracking data. Check corresponding HSLR/HSLS-DB elements for consistent configuration (IDENT-terminal) If the current message occurs without the corresponding PS message please replace PM645/PM646.
Communication error	HSL channel 2 - time-out of user data (CS) / Receive time-out of planned tracking data.	Same actions as for message "HSL channel 1 - time-out of user data (CS)" mentioned above. If the current message occurs without the corresponding PS message please replace PM645/PM646.
Communication error	HSL channel 1 - time-out of user data (PS) / Receive time-out of planned tracking data.	Same action as for message "HSL channel 1 - time-out of user data (CS)" mentioned above. If the current message occurs without the corresponding CS message please replace PM645/PM646.

Table 5-4. Error Texts in Error Report (Continued)

Type of error	Error message / Significance	Corrective action
Communication error	HSL channel 2 - time-out of user data (PS) / Receive time-out of planned tracking data.	Same action as for message 'HSL channel 1 - time-out of user data (CS)' mentioned above. If the current message occurs without the corresponding CS message please replace PM645/PM646.
Communication error	DX test impossible channel 1/	Check the configured station address of the station connected to HSL channel 1. It must be different from the local station address.
Communication error	DX test impossible channel 2/	Same action as for message 'DX test impossible channel 1' mentioned above.
Communication error	Lost of token /	Take off one of the HSL cables and plug it in again and after approx. 1 min. a new token circulation should take place.
Communication error	Handshake error on token passing /	Same action as for message 'Lost of token' mentioned above.
Application error	User request for relay dropout / A responding of the Second Shutdown Path caused via REL_OFF terminal of Processor Module DB element.	Check the application program (For protection systems the application program mostly supports fault reactions concerning DX610 test, CRC comparison).

5.4 Fault Finding and User Repair

5.4.1 Introduction

In all situations when the controller has stopped you should carefully read the halt codes at the diagnostic display of the Processor Module and error messages available before you proceed. See Section 5.3.5, Faults Stopping the System and Section 5.3.6, Faults Not Stopping the System.

Diagnostics are available in different forms for rapid localization of the source of the equipment malfunction. Hardware error is usually corrected by replacing the faulty unit, which is returned to ABB Logistics for repair. The smallest replaceable unit is normally a module or an apparatus like a power supply unit.

Disturbances and system halt caused by software error are commonly solved by a manual system restart. Sometimes you must load the application program, reinforcing the need for actual backup copies. In such situations, it is strongly recommended that you take careful note of all available stored error codes and error messages before an eventual program loading and new initialization. Then contact ABB for further information.

External faults in process wiring and transducers can also affect the function of the controller. However, this type of fault is not discussed in this manual.

Debugging of PC programs is described in the manual *AMPL Configuration Advant Controller 100 Series*.

5.4.2 Diagnostics

System level diagnostics, including Advant Controller 160, have an error reporting and indicating structure that makes use of diagnostic information displayed at engineering or operator station (see Section 5.3, Error Messages), diagnostic displays and LED status indicators to indicate the status of hardware (see Section 5.2, Hardware Indicators).

Comprehensive system diagnostics not only detect problems, but also let an operator know where a problem is located. The diagnostic features of the system provide for timely, reliable detection and notification of both software and hardware errors.

The diagnostic philosophy for the Advant OCS system is that single-fault situations are detected and processed.

The diagnostics support the maintenance philosophy of fault isolation and replacement down to module or subassembly level.

Advant Controller 160 performs a variety of diagnostic and supervision functions to continuously monitor the correct operation of the whole system. Each of the modules has its own diagnostic functions. The CPU module monitors the system as a whole by collecting all the diagnostic information and checking the consistency of the hardware configuration and the application software.

The supervision functions are subdivided into the following groups:

- Problem detection.
- Signalling the nature of the problem.
- Automatic reaction to problems.

Each module is equipped with two LED indicators, FAULT and RUN. During normal operation, the green LED RUN is lit on all modules. The red LED FAULT lights only if a problem occurs on the module.

A module indicating FAULT should be replaced by maintenance staff and shipped to ABB Logistics for repair.

The status of the modules and of the I/O signals is also indicated by the associated DB elements. Missing modules are also signalled by the function supervising the configuration on the associated DB elements. The status signals on the DB elements can be processed by the PC program in the same way as other signals. This feature enables you to include your own error handling routines in application programs, for example, to interlock control loops if important signals are disturbed.

Texts providing more detailed information about problems are displayed by Advant Station 100 Series Engineering Station.

Severe problems (for example, component errors) in the Processor Module stop the Processor Module. These errors also switch a relay in the Processor Module.

The digital outputs are to be set to the off state and analog outputs are to be set to 0 m (0 V). This required behavior must be configured with use of the relay outputs of the Processor Modules (see Section 2.3, Shut-down Procedures, Section 2.3.2, Controller and I/O).

The diagnostic function displays an error code on the front of the CPU module to facilitate fault tracing.

The I/O modules supervise whether or not the process connector is correctly inserted. If the process connector is withdrawn, operation of the I/O module is immediately inhibited (that is, it is no longer in the RUN state), and the error is indicated on the associated DB element module and by the DB elements channel in the CPU. If the process connector is not inserted, the module cannot be switched to RUN.

The CPU checks the consistency of the module configuration specified by the DB elements and the actual configuration of the modules. This check is performed each time a module is switched on before it is switched to RUN. If the module installed does not correspond to the type of module specified by the module DB element, then the module is not switched to RUN and the error is indicated on the associated channel DB elements.

Modules without an associated module DB element are not switched to RUN.

5.4.3 Fault Tracing Principles

Fault tracing must be performed in a systematic and logical manner. Before starting up a system which has not been in operation before, always check that:

- The mains voltage is connected.
- All modules are installed properly.
- All modules are in the correct position.
- All connections are made correctly.

If these checks do not reveal a malfunction, continue with the procedure described in Section 5.5, Basic Fault Tracing, and then continue to Section 5.6, Advanced Fault Tracing. See Section 5.4.4, Start-up for instructions on how to restart a system after a fault has been revised.

A fast and simple method of fault tracing is to reduce the system to a minimum by withdrawing all modules except the Processor Module and the power supply. Then reinsert them, one by one, to their positions until the fault recurs.

5.4.4 Start-up

Advant Controller 160 must be restarted after the system is forced to shut down by a severe fault.

You can do this using RES, which results in a cold start with the MODE selector in either the COLD START position.

Attempt to diagnose the fault before restarting any system displaying error codes. This can consist, for example, of noting error indications and error codes, or starting up the system with the MODE selector in the STOP position and reading out the error report with the Engineering Station.

5.4.5 Safety

CAUTION

Read Section 5.1.1, Safety Regulations before beginning to trace a fault.

5.4.6 Process Output Behavior

See Section 3.1.11.1, Process Outputs Behavior at Interruptions for behavior of control outputs in case of faults.

5.5 Basic Fault Tracing

5.5.1 Equipment

The signal LEDs provided on Advant Controller 160 are normally sufficient for tracing faults. The following equipment, however, simplifies the work and should be available:

- A multimeter.
- Standard hand-held measuring & test tools.
- The system documentation according to Section 1.5, Related Documentation.
- Spare modules and fuses.

5.5.2 Fault Tracing Procedure

The following diagram shows the suggested fault tracing procedure. The numbers indicate the sequence of the fault tracing steps. You will find helpful information about each step on the following pages.

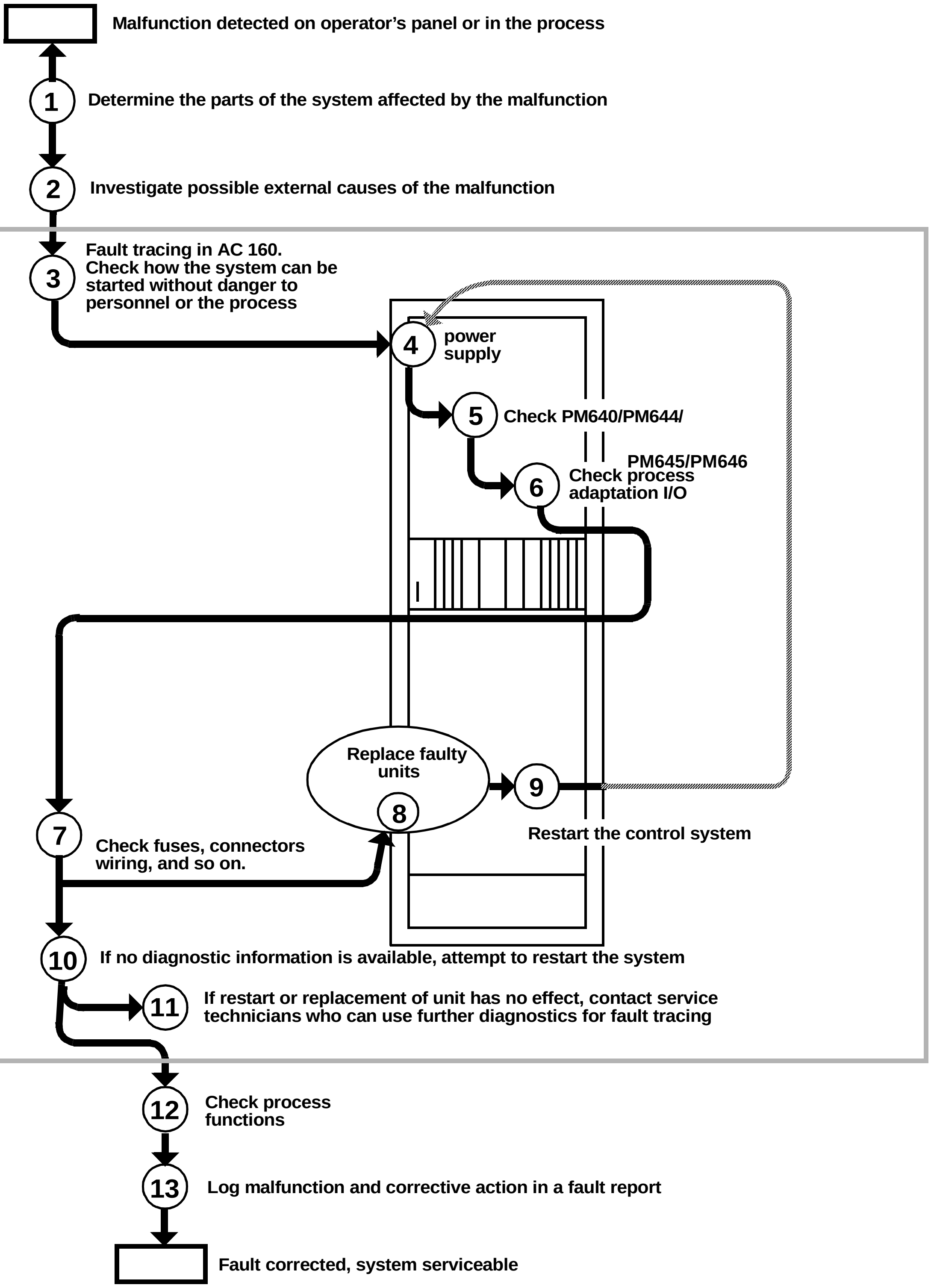

Malfunction detected on operator's panel or in the process
1
Determine the parts of the system affected by the malfunction
2
Investigate possible external causes of the malfunction
3
Fault tracing in AC 160.
Check how the system can be started without danger to personnel or the process
4
power supply
5
Check PM640/PM644/ PM645/PM646
6
Check process adaptation I/O
7
Check fuses, connectors wiring, and so on.
Replace faulty units
8
9
Restart the control system
10
If no diagnostic information is available, attempt to restart the system
11
If restart or replacement of unit has no effect, contact service technicians who can use further diagnostics for fault tracing
12
Check process functions
13
Log malfunction and corrective action in a fault report
Fault corrected, system serviceable

Figure 5-4. Fault Tracing Procedure

(1) Locating the Cause of a Malfunction

Information displayed on the operator’s panel and from the process can give some indication as to where a fault is located.

Experience shows that approximately 85% of all faults occur in the process itself, 10 percent in the application program and five percent in the control system hardware.

It is always advisable to follow this procedure to locate the cause of a malfunction to minimize downtime.

(2) External Influences

In an electronic system which has been operating satisfactorily, most malfunctions have external causes. It is, therefore, important when you trace a fault to determine if any external factor such as incorrect handling of equipment, welding work, lightning and/or power failure has caused the malfunction.

(3) Safety When Starting Up and Shutting Down

Advant Controller 160 can only perform its control functions when in normal operation.

Voltage failure, a component fault or restarting manually usually affect the operation of the control system. Control system failure affects the process in different ways of varying gravity:

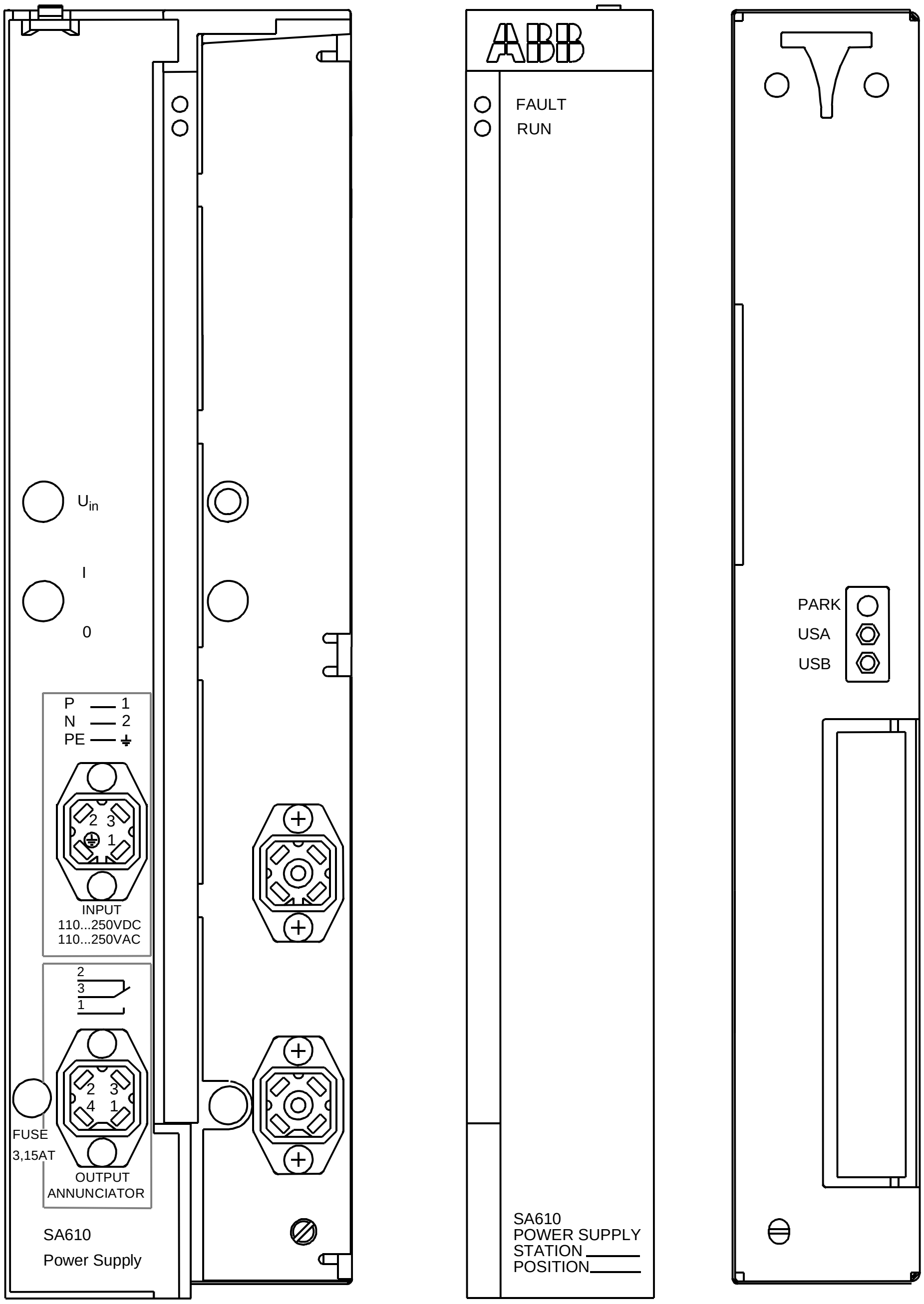
- In a control system with a monitoring character, changes of process status are not registered, but there is no immediate danger to the process.
- Control of continuous processes demands a high degree of availability from the control system. Restarting Advant Controller 160 in such situations can have very serious consequences.

It is, therefore, important to be aware of the local conditions and safety requirements when you start and stop Advant Controller 160.

(4) Checking the Power Supply

An Advant Controller 160 station can be supplied in one of two ways by using:

- SA610 power supply modules.
- An external 24 V DC power source SA 161.



Front door open

Front door close

Rear view

Figure 5-5. Front and Rear Views of the Power Supply Module SA610

Power Supply Module SA610

As long as the green LED RUN on the SA610 lights, the 24 V station voltage is available. The 24 V station voltage can be measured on the USA, USB and ZD terminals of the subracks.

If the red LED FAULT lights up on the SA610, there is an overload or a short-circuit on the 24 V station voltage.

If the green LED RUN does not light, proceed as follows:

- Check the on/off switch on the power supply module.
- Check the green LED U_{in}, which indicates the presence of input voltage (mains voltage, for example, 220 V AC). If U_{in} is missing, check the fuse in the power supply module and then other fuses, circuit-breakers, and so on.

NOTE

24 V should be available on both station voltage lines (USA and USB).

External Power Source SA 161

Illumination of the LEDs marked RUN on the CPU and other modules indicates the presence of their station voltage. The station voltage can be measured on the terminals USA and USB and ZD on the subrack.

The station voltage must be in the range 18 – 30 V DC. If it is too low, the modules probably will not function correctly.

5) Checking the Processor Module and bus extender

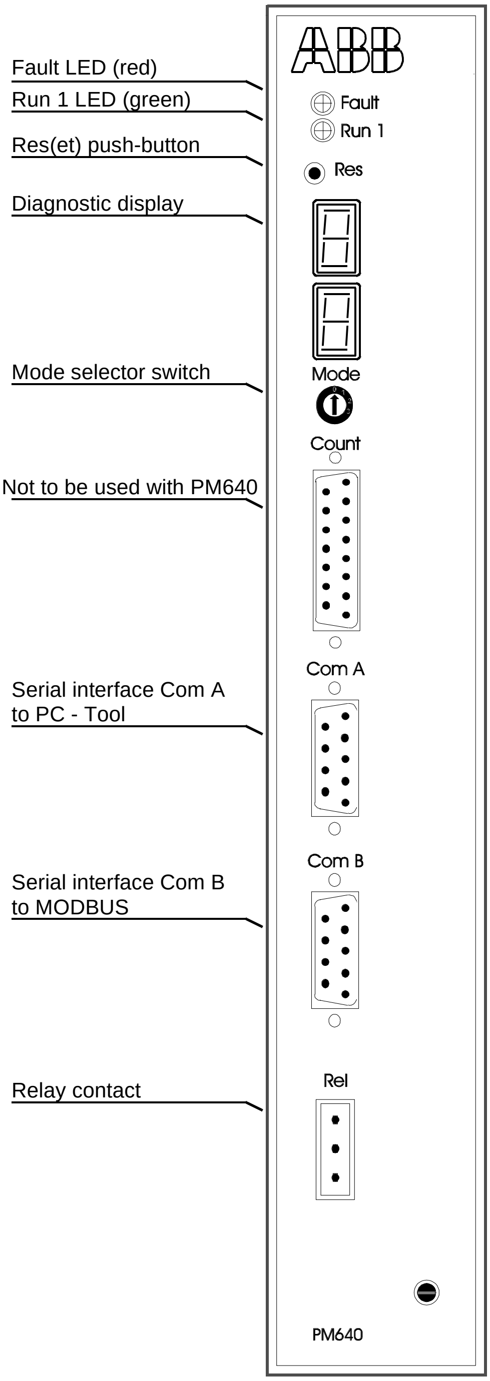


Figure 5-6. Processor Module PM640

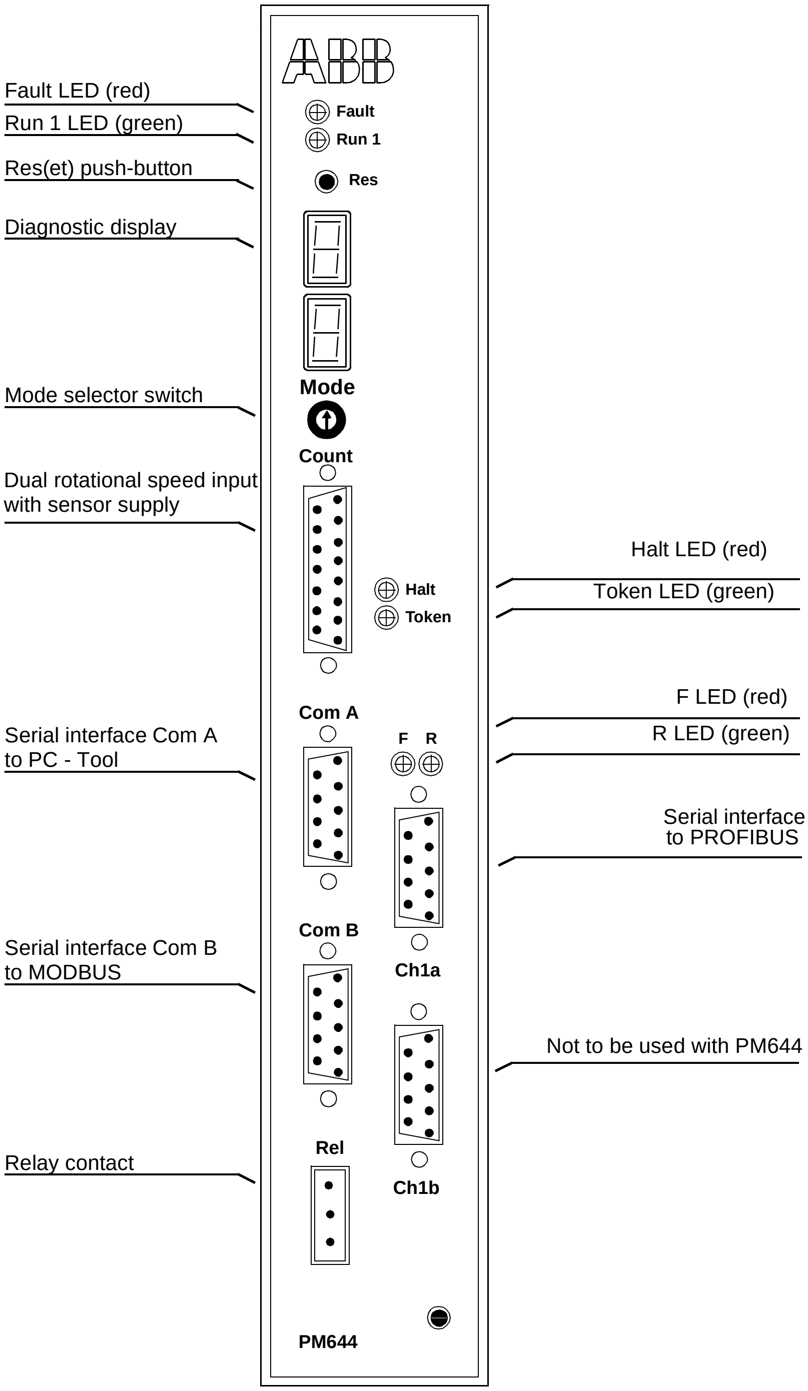


Figure 5-7. Processor Module PM644

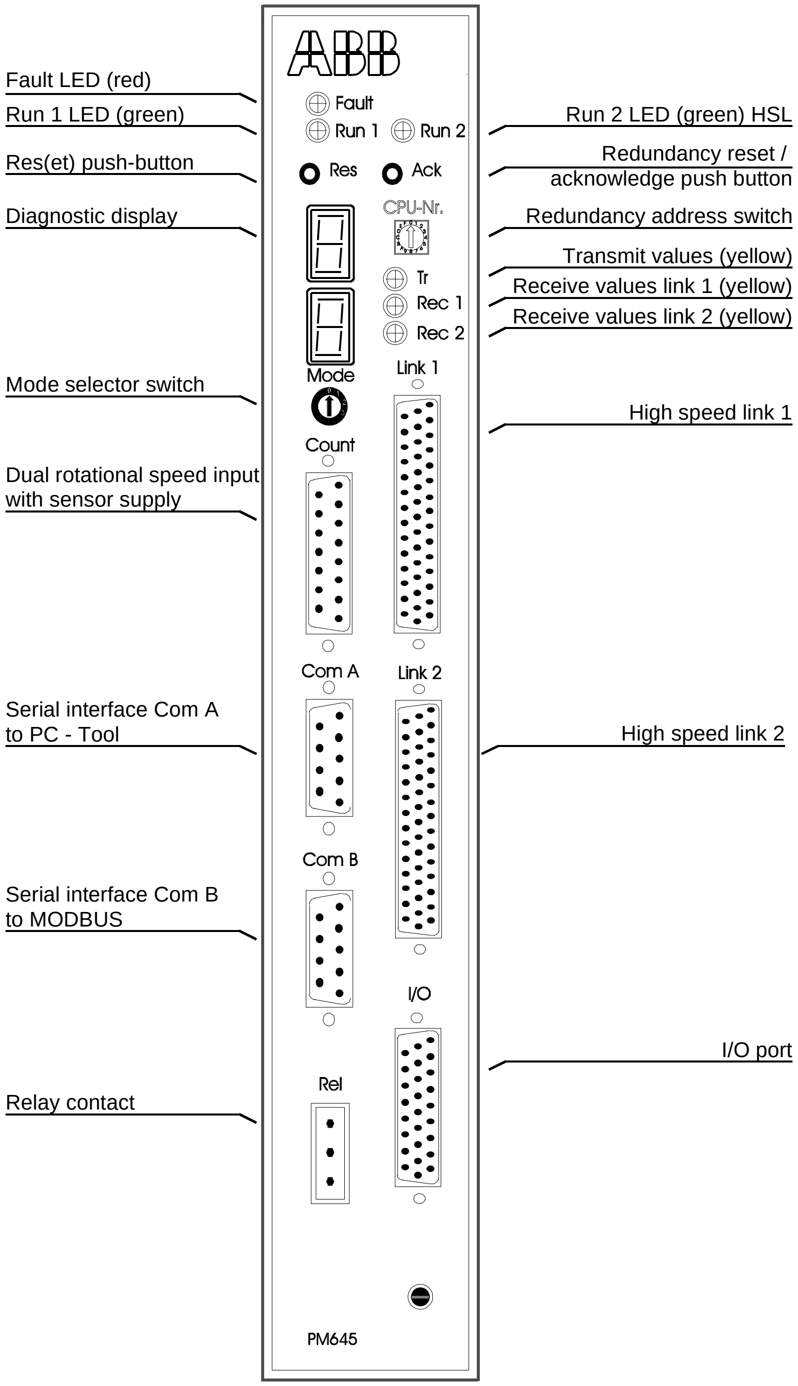


Figure 5-8. Processor Module PM645

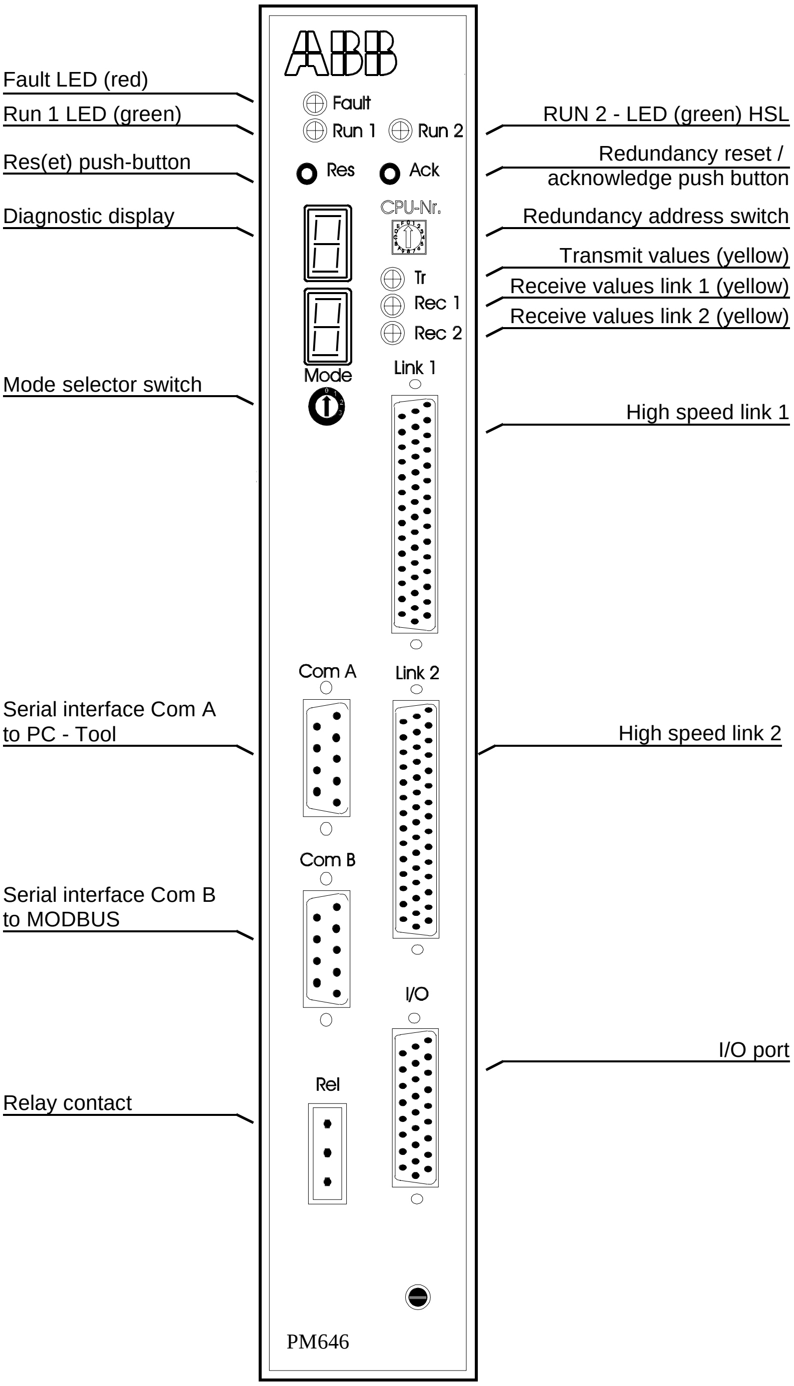


Figure 5-9. Processor Module PM646

Check the following signals on the Processor Module:

- The green LED **Run 1** indicates that the processing section of the Processor Modules is operational.
- The green LED **Run 2** indicates that the communication section of the Processor Module PM645 is operational.
- The green LED R(un) indicates that the communication section of the Processor Module PM644 is operational.
- The red LED **Fault** indicates a severe fault and normally the Processor Module must be replaced.
- The red LED HALT indicates a CPU halt of the communication section of the Processor Module PM644 and normally the Processor Module must be replaced.
- The red LED F(ault) indicates that the communication section of the Processor Module PM644 is initializing or a fault condition exits.
- The diagnostic display indicates the Processor Module operating mode:

  P– = start-up

  P1 = normal operation

  P3 = stop after initialization

  P4 = CPU is not running an application

  P5 = loading application program from PROM

  P6 = Engineering Station is connected and is in the on-line mode

  PL = waiting for download of system software

  PU = loading system software option (enabling options)

  xx = error code.

If a two-digit number (xx) is visible, the system has stopped and the number represents an error code.

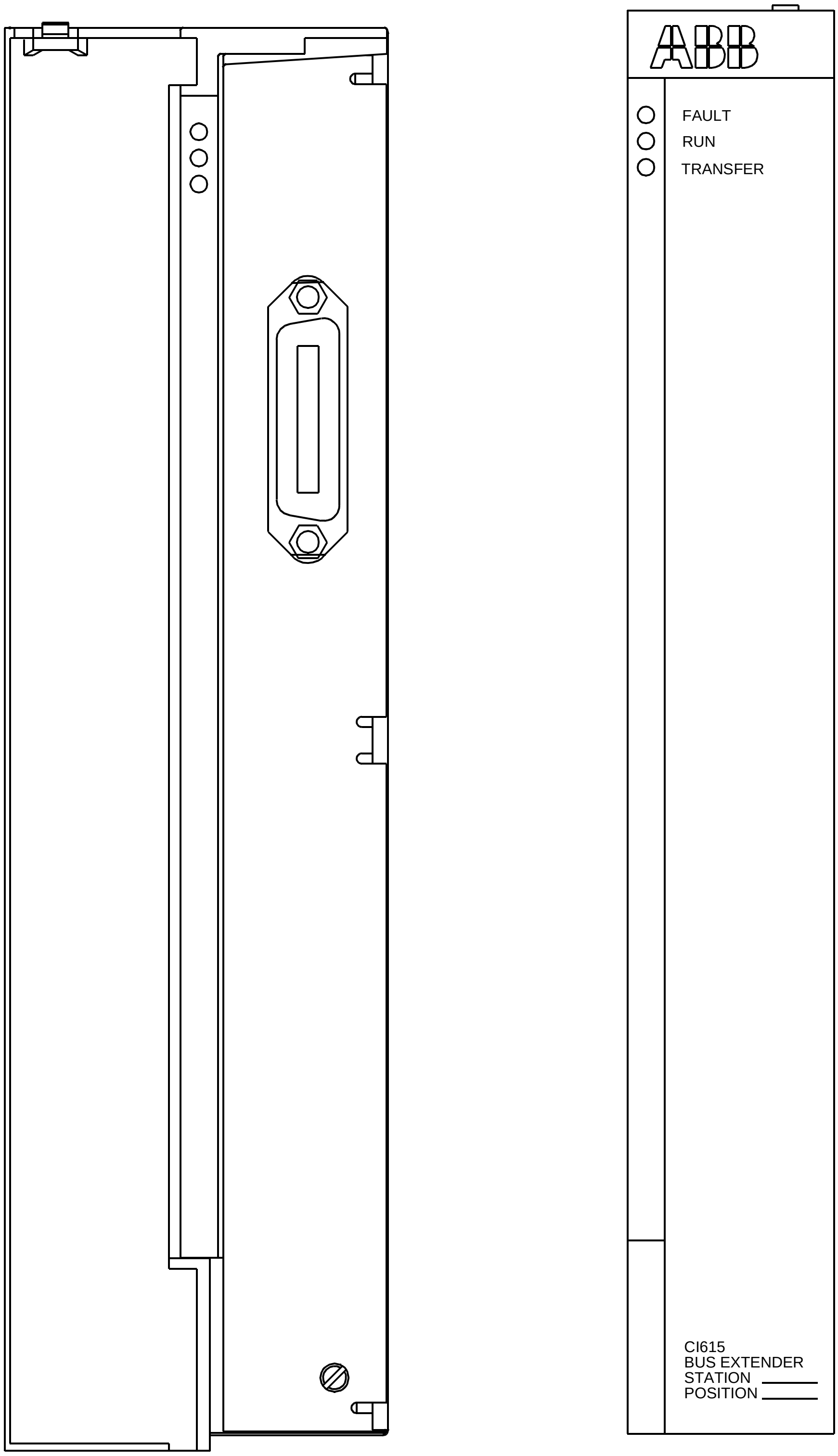


Figure 5-10. Bus Extender Module CI615 with Open Front Door and Front View

Bus Extender C1615

In addition to its function as a bus extension, the bus extender module CI615 (Figure 5-10) installed in the basic station (that is, the station with the Processor Modules) contains the communication and bus cable supervision functions.

- The green LED RUN indicates that the bus extender is operational. If RUN does not light on a CI610 (in the I/O station), it probably cannot be accessed or activated. Check the I/O station address (on the station address switch).
- The red LED FAULT indicates a severe fault and normally the bus extender module must be replaced.
- A flashing LED TRANSFER indicates data read and write via the extension bus.

If the LED TRANSFER does not light on the CI615 (but the Processor Module is operating), it is possible the extension bus is not properly connected or fitted. Check the bus connections and bus terminator TC610.

NOTE

If the LED TRANSFER on a CI610 does not lit, all outputs on the I/O station are set to "0".

(6) Checking the Process I/O

Check the LEDs FAULT and RUN (refer to Chapter 3, Configuration).

- RUN = module in the active (RUN) state.
- FAULT = severe fault detected by the module's self-testing facility.

Action to take in case of a FAULT signal:

- Replace the module with the LED FAULT lit. The LED FAULT always indicates a severe fault which can normally be repaired only in the factory.

Action to take when there is no RUN signal:

- Check whether the process connector is properly fitted.
- Check if the module is activated in the corresponding DB element (IMPL = 1 requires an Engineering Station).
- Try to get more information via error report (requires an Engineering Station).
- If all of the modules with unlit RUN LEDs are in the same I/O station, the fault is probably in the bus extender module CI610 or in the bus cable or the I/O station address is wrong.

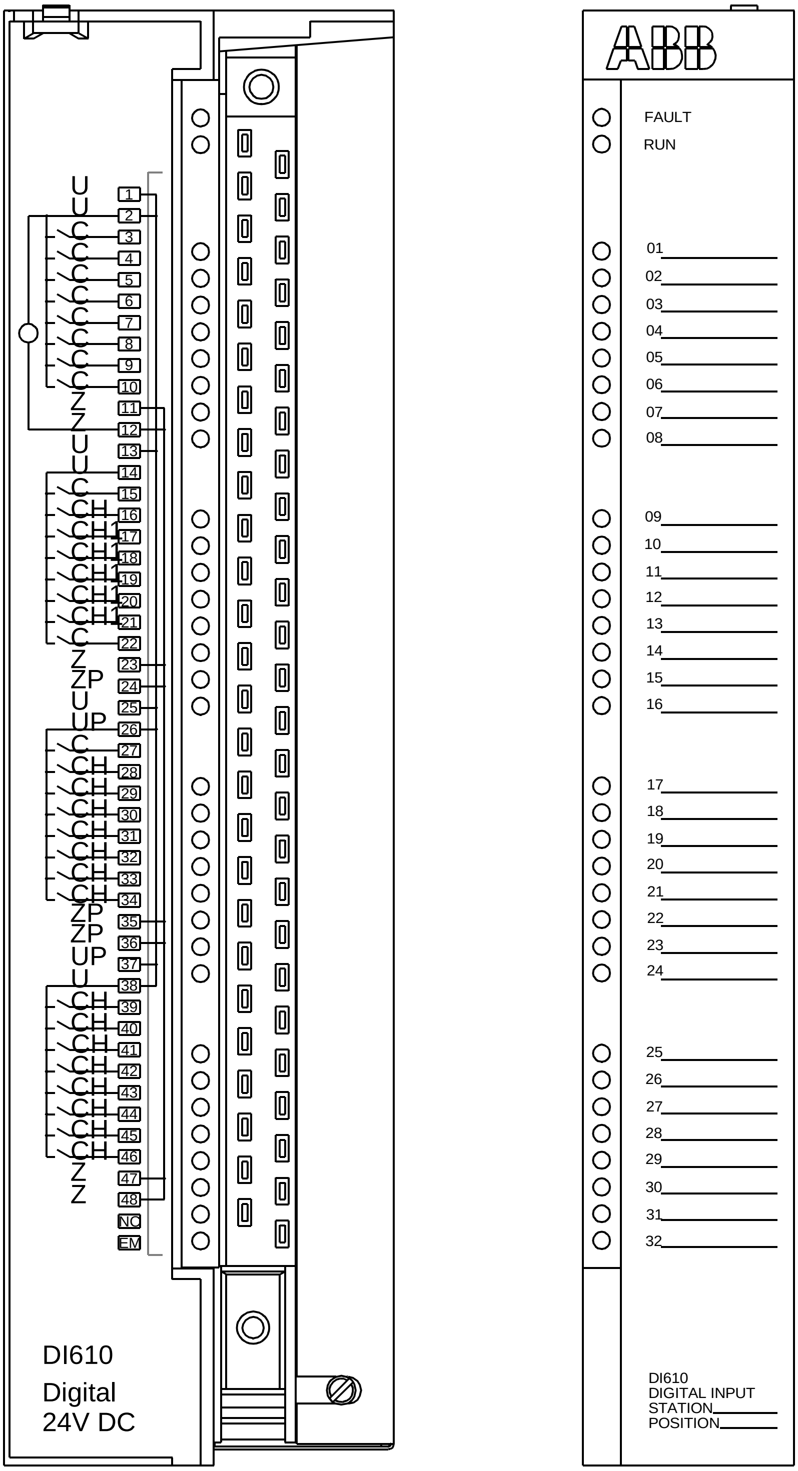


Figure 5-11. Signal Status and Fault Indication on the I/O Modules

Status of I/O Signals

The status of the digital signals (DI, DO) is indicated by a yellow LED for each signal connected to the process:

- Digital input signals: The signal status LED is located in the input signal path, that is, it directly indicates input current.
- Digital output signals: The signal status LED is internally driven, that is, it indicates the internal output signal status (except the status LED of the DO610, which is driven by the process voltage).
- Check the process voltage supply and fuses for process signals. Fuses or circuit-breakers are the most frequent cause of missing process signals.
- Check the signal levels at the terminals of the process connector.

(7) Checking the Installation

Open-circuits, short-circuits and loose connections can occur. Therefore, check as necessary:

- External fuses.
- Station and PCB connectors.
- Wiring, screwed terminals.
- Mechanical installation.

(8) Replacement of Defective Modules

Except MVI submodule (CI532) all modules can be replaced during operation while the voltage supply is switched on. The diagnosis software reconfigures the new module.

Do the following when replacing modules:

- Follow the requirements of Section 5.1.1, Safety Regulations.
- Follow the requirements of Section 5.7.1, Module Replacement.
- Check that the new module is of the correct type.
- Transfer any labels indicating the position, and so on, from the original to the new module.
- Note any symptoms observed and other useful information and attach this information to the module returned for repair.

(9) Restart the Control System

After replacement of the defective modules, restart the control system.

(10) System Restart

If no diagnostic information is available, attempt to restart the system. To restart the system, press the RES push button, which results in a cold start with the MODE selector in either the COLD START position.

(11) Fault tracing by interpretation of fault symptoms

Refer to Section 5.6, Advanced Fault Tracing.

If the diagnostic information presented is insufficient, contact a suitable service workshop to assist you in interpreting the symptoms, or attempt to obtain more details with the aid of the usual service equipment.

(12) Checking process functions

- Compare with the original performance to check that the correct action has been taken.
- Check that the original operating parameters, and so on, have not been changed by the fault tracing action.
- Utilize any checklist which may be available on site.

(13) Log symptoms and corrective action or repairs in a fault report

Information regarding previous malfunctioning can be of great assistance for subsequent maintenance of the equipment. Keep a record of all faults and corrective action taken.

When contacting ABB support line, be sure to have the release and revision numbers of your software ready. The release and revision number for Function Chart Editor (FCB) can be found by clicking **Help | About**. The release and revision number of the system software of your controller are shown in the options report of Function Chart Editor (FCB) (**Target | Report Options**).

5.6 Advanced Fault Tracing

Advanced fault tracing is for the detection of errors in application and system software, and when the system does not operate at all, with the help of:

- LEDs on the modules.
- The diagnostic display on the Processor Module.
- Error reports using the Engineering Station.
- Fault tracing by interpretation of fault symptoms.

The Engineering Station should be available in addition to the equipment necessary for basic fault tracing.

Please refer to Section 5.3.5, Faults Stopping the System and Section 5.3.6, Faults Not Stopping the System which describes faults indicated by diagnostic display on the Processor Module and by error report.

5.6.1 Fault Tracing by Interpretation of Fault Symptoms

Follow this procedure to locate module faults, which do not activate the built-in supervision system, and faults in the signal connections and the wiring.

This type of fault tracing assumes knowledge of the process functions and the availability of circuit diagrams and other relevant documents. Follow this procedure:

- Study the fault symptoms and determine the inputs and outputs affected.
- For example, the fault is on a digital input module. The signal status LED on the module lights, but the value in the data base element is not updated. In the case of analog signals, check first that the signal is activated in the data base element.
- Determine whether the fault is in the process equipment or wiring, or in Advant Controller 160. Do this by measuring the input/output signals at the process connector.
- If the fault is found to be in Advant Controller 160 equipment, attempt to track it in from the process connector to the input/output module and on to the input signal data base element. If the signal is an output signal, the fault is traced in the opposite direction. It should be possible to locate the fault following this procedure.

5.6.2 Voter Test

The Voter of a Processor Module PM645A, PM645B, or PM646 can be tested as described below:

Actions for the Voter test

1. **Remove all cables**
    - between the Processor Modules PM645A, PM645B, or PM646
    - between the Processor Module and the Analog Selector Switches 89AU31
    - between the Processor Module and the Binary Selector Switches 89AL31.
2. **Select invalid CPU-Nr. “F” with the redundancy address switch on the CPU front**
3. **Select Start-Mode STOP with the Mode selector switch on the CPU front**
4. **Press Reset push-button RES.**

Test results and corrective actions

Diagnostic Display	Meaning	Action
“P3”	Voter OK cabling defective	check cabling, replace cabling.
“0E”	Voter defective	replace PM645A/B or PM646.

5.7 User Repair

5.7.1 Module Replacement

5.7.1.1 General

User support for maintenance (and especially for module replacement) has been designed into Advant Controller 160. The system supports you to replace or insert a module during operation.

The system has the following important built-in hardware and software measures designed to cope with the special situation of module replacement:

- When the process connector is removed, the system registers this, error signals are set on DB elements and updating of the "VALUES" is discontinued. Operation of the module is inhibited (the green LED RUN extinguishes) and the outputs are switched off.
- Precautions have been taken (for example, leading ground pins on the bus connectors, and so on) to ensure that whenever a module is withdrawn or inserted, the rest of the system is not disturbed.
- Before an exchanged module can go into operation again, the process connector must be inserted and the diagnostic checks must all be satisfactory. The diagnostic checks include type of module and position (slot).

WARNING

Before replacing a module in a running system, it is important that you examine the consequences. Process equipment may be damaged if critical signals are not updated.

For this reason, it is essential that you know which signals are affected. For example:

- The replacement of a non-redundant bus extender CI615 affects all I/O stations.
- The replacement of a redundant bus extender CI615 may affect all I/O stations with a failed redundant bus extender CI610.
- The replacement of a non redundant Communication Interface affects the complete communication with the respective Advant Fieldbus 100.
- A non redundant Communication Interface CI626, CI627, CI630, or CI631 for Advant Fieldbus 100 must not be replaced during operation due to its controller internal data management tasks (Global Memory). Otherwise the controller goes out of function.
- The replacement of a non redundant Processor Module affects the respective application program incl. all I/O used.
- The replacement of a non-redundant bus extender CI610 affects the whole I/O station.
- The replacement of an I/O module affects all channels on the module.

NOTE

If—in case of a redundant I/O extension—one of the required two bus extenders CI610 of an I/O station is defective or is missing, the CI615 at the same bus line as the operational CI610 must not be replaced. Otherwise the respective I/O station goes out of operation.

NOTE

If—in case of a redundant I/O extension—one of the required two bus extenders CI615 is defective or is missing, the CI610 at the same bus line as the operational CI615 must not be replaced. Otherwise the respective I/O station goes out of operation.

Fully consider and understand the consequences before taking any action.

5.7.1.2 Replacement of an I/O Module

The system software in Advant Controller 160 automatically checks that all I/O modules are operating correctly. In the event of a defective or missing module (for example, during replacement), the module and associated signals are flagged at the "ERR" terminal of the data base elements. The signal value (VALUE) is not updated as long as the error persists.

The I/O module runs a self-testing routine following power-up and during operation. Provided, no serious defect is detected, the red LED (FAULT) extinguishes. The system software checks that:

- The module is in the correct position.
- The module is of the right type.
- The module is not defective.
- The process connector is in place.

If all these points are in order, the green LED (RUN) lights up, the error flag on the data base element is reset and the module switches to the operating mode.

Before replacing output modules (analog or digital), it is advisable to isolate the output signals from the process.

Follow this procedure to replace a faulty or suspect I/O module:

- Read Section 5.1.1, Safety Regulations.
- Open the front door of the module. Remove the paper strip (with the signal names) inside the front door to use again with the new module.
- Release the screw securing the process connector (about 15 turns) until it turns freely. If the module is in operation, it registers that the connector has been removed and stops operating (green LED RUN extinguishes).
- Remove the process connector.
- Release the screw securing the module (about 15 turns) until it turns freely and withdraw the module.
- Check that the new module is the same type as the old one.
- Insert the new module. Ensure that it is fully in place up to the hinge of the subrack. Tighten the module-securing screw. If the module is working correctly, the red LED (FAULT) lights briefly and then extinguishes.

- Insert the process connector and tighten the connector screw. The new module is taken into operation automatically and the green LED (RUN) lights up.
- Exchange the paper strip and close the front door.

5.7.1.3 Replacement of a Bus Extender CI615

In case of **nonredundant I/O extension,** removal of the bus extender CI615 during operation is NOT allowed.

Removing a **redundant bus extender CI615** has no impact on the process if all bus extenders CI610 connected to the same bus extension cable are operational. Otherwise, the defective CI610 shall be replaced first.

Follow this procedure to replace a faulty or suspect redundant bus extender CI615:

- Read Section 5.1.1, Safety Regulations.
- Open the front door of the bus extender and release the two screws on the bus connector.
- Remove the bus connector. The LED (TRANSFER) on the bus extender extinguishes.
- Release the screw securing the module until it turns freely and withdraw the module.
- Check that the new module is of the same type as the old one.
- Insert the new module. Ensure that it is fully in place up to the hinge of the subrack. Tighten the module-securing screw. If the module is working correctly, the red LED (FAULT) lights briefly and then extinguishes.
- Insert the bus connector and tighten the connector-securing screws. The new module starts to operate automatically and the green LED (RUN) and the LED (TRANSFER) light up. The outputs resume normal operation.
- Close the front door.

5.7.1.4 Replacement of a Bus Extender CI610

You can replace the bus extenders CI610 during operation. Removing a nonredundant bus extender CI610 only affects that particular I/O station. If a second redundant bus extender CI610 is available removing a CI610 has no impact on the process.

As soon as the bus extension cable TK610 is disconnected in case of a non redundant I/O extension, communication is interrupted and all outputs—analog and digital—immediately assume “zero” state. The green LED (RUN) remains lit. The “zero” state is the safe position and is defined as follows.

For digital outputs: off state, for example, relays open.

For analog outputs: 0 V or 0 mA.

Follow this procedure to replace a faulty or suspect bus extender CI610:

- Read Section 5.1.1, Safety Regulations.
- Open the front door of the bus extender and release the two screws on the bus connector.
- Remove the bus connector. If more than one I/O station is connected, remove both connectors together, being careful not to disrupt the bus. The LED (TRANSFER) on the bus

extender concerned extinguishes, and all outputs of associated stations assume the "zero" state.

- Release the screw securing the module until it turns freely and withdraw the module.
- Check that the new module is of the same type as the old one.
- Insert the new module. Ensure that it is fully in place up to the hinge of the subrack. Tighten the module-securing screw. If the module is working correctly, the red LED (FAULT) lights briefly and then extinguishes.
- Insert the bus connector and tighten the connector-securing screws. The new module starts to operate automatically and the green LED (RUN) and the LED (TRANSFER) light up. The outputs resume normal operation.
- Close the front door.

5.7.1.5 Replacement of Advant Fieldbus 100 Communication Interface for the Main Control Bus

In case of single Communication Interface CI626, CI627, CI630, or CI631 to a main control bus, removing the module during operation is NOT allowed. Besides the communication task at least one of the interfaces in position 1 or 2 is needed for controller internal data management. Without this function the controller cannot operate.

In case of two available Communication Interfaces CI630/CI631 for the main control bus, you can replace one interface during operation without impact on any controller function.The new Communication Interface is configured automatically and starts to operate automatically.

5.7.1.6 Replacement of Advant Fieldbus 100 Communication Interface for Subordinate Control Bus

You can replace the Advant Fieldbus 100 Communication Interface to the second subordinate control bus during operation. The extent to which communication is affected depends on the particular configuration (for example, redundant bus lines).

In the case of a disconnected single Communication Interface CI626, CI627, CI630, or CI631, the bus remains operational and communication between other stations is unaffected as long as there are other Advant Fieldbus 100 bus master active. The new Communication Interface is configured automatically and starts to operate automatically.

In case of two available Communication Interfaces CI630/CI631 for the subordinate control bus you can replace one interface during operation without impact on any controller function.The new Communication Interface is configured automatically and starts to operate automatically.

Refer to the *Advant Fieldbus 100 User's Guide* for further details.

5.7.1.7 Replacement of a Non Redundant Processor Module

In the event a non redundant Processor Module must be replaced, you must shut down the control application realized with the considered Processor Module. The effect on the process must be considered.

The application program must be loaded in to the new Processor Module and the system must be restarted.

This requires an Engineering Station tool and detailed knowledge of how to load and restart the system.

Refer to the manual *Advant Station 100 Series Engineering Station User's Guide* for details.

5.7.1.8 Replacement of a Redundant Processor Module

If one of two or three redundant Processor Modules must be replaced, the process is not affected by this measure.

After replacement the application program must be loaded in the new Processor Module. In case of CPU redundancy (both redundant Processor Modules within the same station) the new Processor Module is restarted automatically. With station redundancy (redundant Processor Modules within separate stations) the configured Processor Module must be restarted.
This requires an Engineering Station tool and detailed knowledge of how to load and restart the system.

5.7.1.9 Replacement of a Power Supply Module SA610

When you replace a power supply module SA610, it is safer to switch off the central mains supply (AC/DC) feeding SA610. This does not necessarily mean that you must switch off the complete Advant Controller 160.

NOTE

> If the power supply module is in an I/O station, then you need only switch off this station (if this is not already the case). The rest of the system can remain in operation.

Follow this procedure to replace a faulty or suspect power supply module SA610:

- Switch off mains supply to the power supply module.
- Open the front door of the module and check that the mains voltage is off. The LED (U_{in}) must not be lit.
- Release the screws on the mains connector "INPUT" and the indication connector "OUTPUT ANNUNCIATOR" and remove both connectors.
- Release the screw securing the module until it turns freely and withdraw the power supply module from the subrack.
- Check that the jumpers (USA, USB) on the new module are in the correct positions (same positions as on the old unit). For more information on these two jumpers, see Section 4.2, Operating Instructions.
- Insert the new module and tighten the module-securing screw. Fit the mains cable and the indication cable and tighten their securing screws.
- Switch on the mains supply (LED U_{in} lights up) and switch on the power supply module (I/O switch). If the module is operating correctly, the green LED (RUN) lights up and the red LED (FAULT) stays dark.

5.8 Calibration of Analog Input and Outputs

During the course of manufacture, all measurement and output ranges of analog I/O modules are calibrated at an ambient temperature of 25°C. Normally, the modules need no further calibration.

Should you find, however, that the accuracy is outside the specified limits (for example, due to component failure), send the module to ABB Logistics for repair. You cannot recalibrate these units yourself.

The analog modules are designed in such a way that component aging has little affect on specified accuracy. This is the result of:

1. **Use of high-quality, low-drift components. For example, the analog circuits do not include any potentiometers (which are often the cause of drift problems).**
2. **Use of self-calibration techniques in modules of high-specified accuracy (high-end modules). The self-calibration techniques are based on high-precision resistors and on voltage sources with extremely low drift due to temperature and aging.**

See *S600 I/O Hardware Reference Manual* and *S600 I/O Hardware Advant Controller 160 Reference Manual* for accuracy of individual analog I/O modules.

Appendix A Hardware Components

A.1 Hardware Components listed in Alphabetical Order

The list below contains a complete list of all types of hardware components related to Advant Controller 160 and S600 I/O. They are listed in alphabetical order.

A reference is given telling you where to find a module description, including important technical data:

- AC160 refers to this manual, *Advant Controller 160 User’s Guide*
- S600 refers to *S600 I/O Hardware Reference Manual*
- S600/AC160 refers to *S600 I/O Hardware Advant Controller 160 Reference Manual*
- AF 100 refers to *Advant Fieldbus 100 User’s Guide*
- PROFIBUS-DP refers to *PROFIBUS-DP Advant Controller 160 User‘s Guide*
- RCOM, MODBUS, and 3964R refer to the respective User’s Guides. The performance data there given are valid for Advant Controller 110 and can be used as worst case figures for Advant Controller 160.

Table 1-1. Hardware Components listed in Alphabetical Order

Type	Denomination	Reference to description
AI610	Analog input module	S600
AI620	Analog input module	S600
AI625	Analog input module	S600
AI630	Analog input module	S600
AI635	Analog input module	S600
AO610	Analog output module	S600
AO650	Analog output module	S600
AX645	Analog input/output module	S600/AC160
AX646	Analog input module	S600/AC160
CI532V01	RCOM communication submodule	RCOM
CI532V02	MODBUS communication submodule	MODBUS
CI532V03	Siemens 3964R communication submodule	3964R
CI610	Bus extender module for I/O station	S600
CI615	Bus extender module for Basic Station	S600

Table 1-1. Hardware Components listed in Alphabetical Order (Continued)

Type	Denomination	Reference to description
CI626	AF 100 communication module (coax cable)	S600
CI627	AF 100 communication module (twisted pair cable)	S600
CI630	AF 100 communication module (coax cable, optionally redundant)	S600/AC160
CI631	AF 100 communication module (twisted pair cable, optionally redundant)	S600/AC160
DI610	Digital input module	S600
DI620	Digital input module	S600
DI621	Digital input module	S600
DI622	Digital input module	S600
DI635	Digital input module	S600
DI636	Digital input module	S600
DI650	Digital input module	S600
DI651	Digital input module	S600
DI652	Digital input module	S600
DI685	Digital input module	S600/AC160
DO610	Digital output module	S600
DO620	Digital output module	S600
DO625	Digital output module	S600
DO630	Digital output module	S600
DP620	Pulse counter module	S600
DP640	Rotational speed signal input module	S600/AC160
DX610	Relay output module	S600/AC160
–	I/O interface cable set	3BDS 100 575 (RC Germany)
PM640	Processor Module non redundant	AC160
PM644	Processor Module with PROFIBUS interface and rotational speed signal input	AC160, PROFIBUS-DP

Table 1-1. Hardware Components listed in Alphabetical Order (Continued)

Type	**Denomination**	**Reference to description**
PM645A	Processor Module with high speed link and redundancy voter	AC160
PM645B	Processor Module with high speed link and redundancy voter and rotational speed signal input	AC160
PM645C	Processor Module with high speed link and rotational speed signal input	AC160
PM646	Processor Module with high speed link and redundancy voter used for safety system applications	AC160
RB601	Dummy module	S600
RC610	Cable duct	S600
RC620	Fan unit	S600
RF615	Basic subrack for I/O station	S600
RF616	Basic subrack for basic station	AC160
RF620	Extension subrack	S600
SA610	Power supply module	S600
SA161	Power supply	AC160
SA162	Power supply	AC160
SA171	Power supply for field devices	AC160
SA172	Power supply for field devices	AC160
SC610	Submodule carrier	S600
SX540	Power switch and distribution unit	AC160
SX542	Power distribution unit	AC160
SX554	Distribution unit 60 V d.c.	AC160
TC513	AF100 Modem conversion coaxial/twisted pair	AF 100
TC514	AF100 Modem conversion twisted pair/optical	AF 100
TC515	AF100 Modem repeating twisted pair/twisted pair	AF 100
TC610	Terminator for bus extension	S600

Table 1-1. Hardware Components listed in Alphabetical Order (Continued)

Type	Denomination	Reference to description
TC630	AF100 Modem conversion coaxial/optical	AF 100
TF620	Front connector for I/O modules	S600
TK610	Bus extension cable	S600
TK612	Bus cable	S600
TK615	Station voltage cable	S600
TK630	Process cable with front connector	S600
TK640	Screened process cable with front connector	S600
TK661	CPU connection cable set for data exchange	AC160
TK662	CPU connection cable set for redundancy	AC160

A.2 Hardware Components listed in Functional Order

The list below contain a complete list of all types of hardware components related to Advant Controller 160 and S600 I/O. They are listed in functional order.

A reference is given telling you where to find a module description, including important technical data:

- AC 160 refers to this manual, *Advant Controller 160 User's Guide*
- S600 refers to *S600 I/O Hardware Reference Manual.*

Table 1-2. Hardware Components listed in Functional Order

Type	Denomination	Reference to Description
	Analog input modules	
AI610	Analog input module	S600
AI620	Analog input module	S600
AI625	Analog input module	S600
AI630	Analog input module	S600
AI635	Analog input module	S600
AX646	Analog input module	S600/AC160
	Analog output modules	
AO610	Analog output module	S600
AO650	Analog output module	S600

Table 1-2. Hardware Components listed in Functional Order (Continued)

Type	Denomination	Reference to Description
	Analog input/output modules	
AX645	Analog input/output module	S600/AC160
	Digital input modules and pulse counter modules	
DI610	Digital input module	S600
DI620	Digital input module	S600
DI621	Digital input module	S600
DI622	Digital input module	S600
DI635	Digital input module	S600
DI636	Digital input module	S600
DI650	Digital input module	S600
DI651	Digital input module	S600
DI652	Digital input module	S600
DI685	Digital input module	S600/AC160
DO610	Digital output module	S600
	Digital output modules	
DO620	Digital output module	S600
DO625	Digital output module	S600
DO630	Digital output module	S600
DP620	Pulse counter module	S600
DP640	Rotational speed signal input module	S600/Ac160
DX610	Relay output module	S600/AC160
	Processor Modules	
PM640	Processor Module nonresident	AC160
PM644	Processor Module with PROFIBUS interface and rotational speed signal input	AC160, PROFIBUS-DP
PM645A	Processor Module with high speed link and redundancy voter	AC160

Table 1-2. Hardware Components listed in Functional Order (Continued)

Type	Denomination	Reference to Description
PM645B	Processor Module with high speed link and redundancy voter and rotational speed signal input	AC160
PM645C	Processor Module with high speed link and rotational speed signal input	AC160
PM646	Processor Module with high speed link and redundancy voter used for safety system applications	AC160
TK661	CPU connection cable set for data exchange	AC160
TK662	CPU connection cable set for redundancy	AC160
	Communication (modules, cables, terminators and so on)	
TK612	Bus cable	S600
CI610	Bus extender module for I/O station	S600
CI615	Bus extender module for Basic Station	S600
TK610	Bus extension cable	S600
TC610	Terminator for bus extension	S600
CI626	AF 100 communication module (coax cable)	S600
CI627	AF 100 communication module (twisted pair cable)	S600
CI630	AF 100 communication module (coax cable, optionally redundant)	S600/AC160
CI631	AF 100 communication module (twisted pair cable, optionally redundant)	S600/Ac160
TC513	AF100 Modem conversion coaxial/twisted pair	AF 100
TC514	AF100 Modem conversion twisted pair/optical	AF 100
TC515	AF100 Modem repeating twisted pair/twisted pair	AF 100
TC630	AF100 Modem conversion coaxial/optical	AF 100
SC610	Submodule carrier	S600
CI532V01	RCOM communication submodule	RCOM AC 110

Table 1-2. Hardware Components listed in Functional Order (Continued)

Type	Denomination	Reference to Description
CI532V02	MODBUS communication submodule	MODBUS AC 110
CI532V03	Siemens 3964R communication submodule	3964R AC 110
	Power supply (modules, distribution units, cables and so on)	
SA610	Power supply module	S600
SA161	Power supply	AC160
SA162	Power supply	AC160
SA171	Power supply for field devices	AC160
SA172	Power supply for field devices	AC160
SX540	Power switch and distribution unit	AC160
SX542	Power distribution unit	AC160
SX554	Distribution unit 60 V d.c.	AC160
TK615	Station voltage cable	S600
	Other components	
RF615	Basic subrack for I/O station	S600
RF616	Basic subrack for basic station	AC160
RF620	Extension subrack	S600
RC610	Cable duct	S600
RC620	Fan unit	S600
TF620	Front connector for I/O modules	S600
TK630	Process cable with front connector	S600
TK640	Screened process cable with front connector	S600
RB601	Dummy module	S600

Appendix B   Processor Modules

B.1 PM640

Application

The PM640 is a powerful non redundant Processor Module for Advant Controller 160 systems for the control and supervision of processes and equipment in power plant environments.

The PM640 can be placed in the positions 3 to 8 of the basic station. In multiprocessing applications up to 6 Processor Modules PM640, PM644, PM645, and PM646 can be placed in one controller. One Communication Interface module CI630/CI631 or CI626/CI627 is always necessary for the correct operation of the Processor Modules.

The Processor Module PM640 is based on a 32-bit Motorola MC68360 processor.

Module replacement

PM640 can be replaced under voltage, but process control is interrupted. After replacement the Processor Module and its assigned I/O channels must be restarted.

Technical data

Table 2-1. PM640 Technical Data

Features	Data
Processor	Motorola MC68360 Microprocessor, 33 MHz (1)
Memory	2 MByte Flash PROM system software 1 MByte Flash PROM application program and boot sector 2 MByte SRAM for application purposes
Real Time Clock (RTC)	Built in for time and calendar functions
Watchdog	1 software watchdog activated after 10 ms 1 external hardware watchdog activated after 150 ms
Interfaces Com A and Com B	2 RS 232C opto-isolated serial interfaces, V24

Table 2-1. PM640 Technical Data (Continued)

Features	Data
Interface connector Com A and Com B	9-pin Sub-D, female (per interface) Section 1: Pin 2 – TxD Pin 3 – RxD Pin 5 – GND
Relay connector	3-pin connector Pin 2 – Common Pin 1 – Normally closed when Processor Module in operational mode Pin 3 – Normally open when Processor Module in operational mode
Relay contact	
Max. voltage	48 V d.c.
Max. current	1.2 A
Max. DC switching power	30 W
Max. Contact fuse	1 A, quick-acting
Power dissipation	< 6 W

(1) Processor Modules without BSE article number are equipped with 25 MHz clock with therefore decreased performance.

Front view

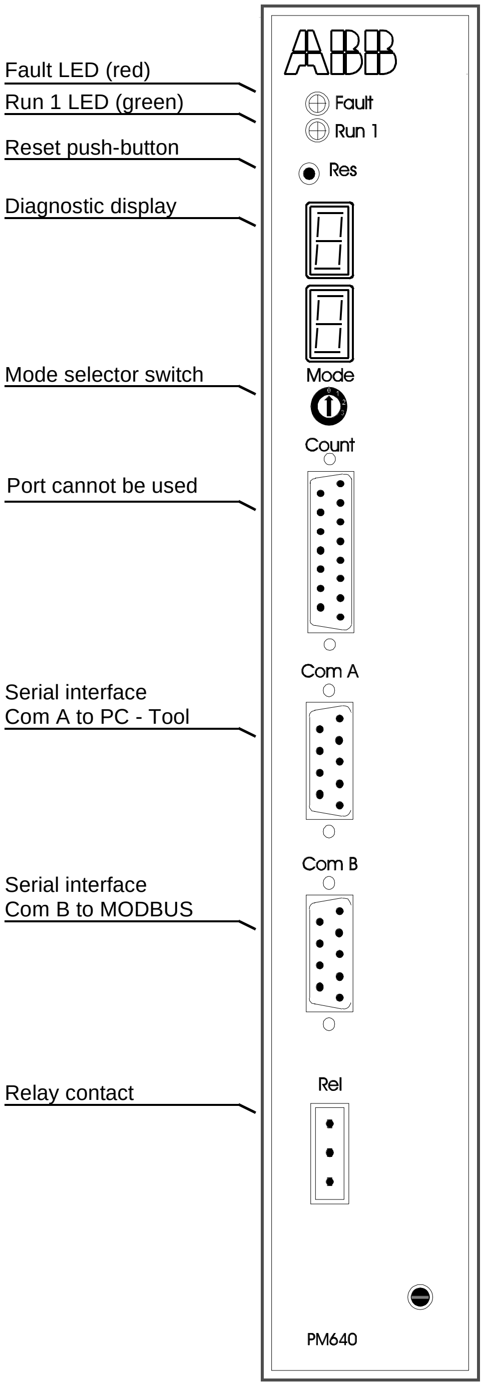


Figure 2-1. PM640 Front View

Functional description

The Processor Module PM640 is based on a 32-bit Motorola MC68360 processor.

The system software includes diagnostic routines which check the Processor Module PM640 and all used I/O and interface modules during initialization and ensure system integrity during the execution of the application program. Dedicated reactions can be defined within the application program. The system software also monitors whether the Processor Module has sufficient capacity to perform its functions within the times specified. If it does not, the Processor Module inhibits the application. The system software detects when I/O modules are withdrawn. New modules added to the application via the DB elements are initialized automatically.

During power-up, the functions of the Processor Module and the contents of application and system PROM are checked as well as the internal RAM of the Processor Module PM640. While the application program is running, the diagnostic routines continue checking operation without impact on the execution of the application.

Memory

The Processor Module is supplied with a built-in memory. Additionally one module CI630 (or CI626) is necessary in the same controller and used as global memory for communication between the Processor Modules.

The application program is stored in a 1 MByte Flash PROM. The application runs from an SRAM copy of the Flash PROM.

On the Processor Module, 2 MBytes of SRAM are available.

The SRAM copy of the program permits easy and quick modification and debugging of an application. After modification of an application, you can copy the new version back to the Flash PROM (back up).

The BASE system software and the system software options are loaded via **Com A** on front of the module to the Flash PROM. It is not necessary to replace the Flash PROM or to open the Processor Module. A system software change can be performed directly in the controller on-site.

Backplane

PM640 is to be connected to the multi master backplane. The respective basic subrack RF616 is to be used.

Indication of module status

Three LEDs and a diagnostic display indicate the status of the module.

LED-Status indication

Run 1 LED

The **Run 1** LED is green and indicates that the Processor Module is up and running.

Fault LED

The **Fault** LED is red and indicates a fault condition on the Processor Module.

Diagnostic display

The diagnostic display consists of an upper part and a lower part and indicates:

- Error codes in case of a system stop of the Processor Module

  The LED **Run 1** does not light and "P" is not shown on the diagnostic display.

- Processor Module functions in the system

  The character "P" is always shown in the upper part. A digit or a character which indicates the control mode in accordance with the examples below is shown in the lower part.

The diagnostic display indicates the Processor Module's operating mode as follows:

P– = start-up

P1 = normal operation

P3 = stop after initialization

P4 = Processor Module is not running an application program

P5 = loading application program from PROM

P6 = Engineering Station is connected and is in the on-line mode

PL = waiting for download of system software

PU = loading system software option

xx = error code.

If a two-digit number (xx) is visible, the system has stopped and the number represents an error code.

Res push-button

Pressing the **Res** push-button initiates a cold start of the Processor Module.

Mode selector

The **Mode** selector has four positions but only position 0 and 1 are used. The mode selector defines the power-up and restart behavior of the Processor Module. If possible, a restart is made automatically after severe error is detected.

Mode 0 (Stop – Mode)

> The user can prevent the application program from starting if the mode selector is in position 0. The system software continues execution to allow access to the stored error messages using Advant Station 100 Engineering Station.

Mode 1 (Cold start – Mode)

The initialization procedure starts from the beginning and hardware and software are reset to their initial states. Application software is loaded from the internal PROM into the RAM. The cold start procedure is executed after power-up and after pressing the **Res** push button.

Serial interface connections Com A and Com B

There are two serial interfaces on the Processor Module:

- Front connector **Com A** to connect Advant Station 100 Engineering Station. Communication speed is fixed at 9600 bit/sec.
- Front connector **Com B** for exchanging data using the optional Modbus protocol with an operator station based on a personal computer. Communication speed is fixed at 9600 bit/sec.
- No parity; 1 Stop Bit, 1 Start Bit.

Relay contact (floating)

The **Rel** contact can be wired in closed-circuit principle (use Pin 1 and Pin 2) or in open-circuit principle (use Pin 3 and Pin 2).

During normal operation with closed-circuit principle the contact is closed. In case of severe errors or during reboot the contact is open.

During normal operation with open-circuit principle the contact is open. In case of severe errors or during reboot the contact is closed.

B.2 PM644

Application

The PM644 is a powerful non redundant Processor Module with PROFIBUS-DP master interface for Advant Controller 160 for the control and supervision of processes and equipment in power plant environments.

The PM644 can be placed in the positions 3 to 8 of the basic station. In multiprocessing applications up to 6 Processor Modules PM640, PM644, PM645 and PM646 can be placed in one controller. The data communication between these Processor Modules takes place via the global memory in the Communication Interface CI630 (or CI626). One communication module CI630 (or CI626) is always necessary for the correct operation of the Processor Modules.

The Processor Module PM644 is based on a 32-bit Motorola MC68360 processors.

Module replacement

PM644 can be replaced under voltage, but process control is interrupted. After replacement the Processor Module and its assigned I/O channels must be restarted.

Technical data

Table 2-2. PM644 Technical Data

Features	Data
Processor for application program	Motorola MC68360 Microprocessor, 33 MHz (1)
Memory for application program	2 MByte Flash PROM system software 1 MByte Flash PROM application program and boot sector 2 MByte SRAM for application purposes
Processor for PROFIBUS communication	Motorola MC68360 Microprocessor, 33 MHz
Memory for PROFIBUS communication	2 MByte Flash PROM system software 2.25 MByte SRAM
Real Time Clock (RTC)	Built in for time and calendar functions
Watchdog	1 software watchdog activated after 10 ms 1 external hardware watchdog activated after 150 ms
Count interface	RS 422 interface, 15-pin Sub-D, female
Interfaces Com A and Com B	2 RS 232C opto-isolated serial interfaces, V24

Table 2-2. PM644 Technical Data (Continued)

Features	Data
Interface connector Com A and Com B	9-pin Sub-D, female (per interface) Section 1: Pin 2 – TxD Pin 3 – RxD Pin 5 – GND
Relay connector	3-pin connector Pin 2 – Common Pin 1 – Normally closed when Processor Module in operational mode Pin 3 – Normally open when Processor Module in operational mode
Relay contact	
Max. voltage	48 V d.c.
Max. current	1.2 A
Max. DC switching power	30 W
Max. Contact fuse	1 A, quick-acting
Interface Ch1a	RS 485 galvanically separated serial PROFIBUS interface
Interface connector Ch1a	9-pin Sub-D, female Pin 1 – Shield Pin 3 – RxD/TxD-P Pin 4 – CNTR-P Pin 5 – DGNG Pin 6 – VP Pin 8 – RxD/TxD-N Pin 9 – CNTR-N
Power dissipation	< 12 W

(1) Processor Modules without BSE article number are equipped with 25 MHz clock with therefore decreased performance.

Front view

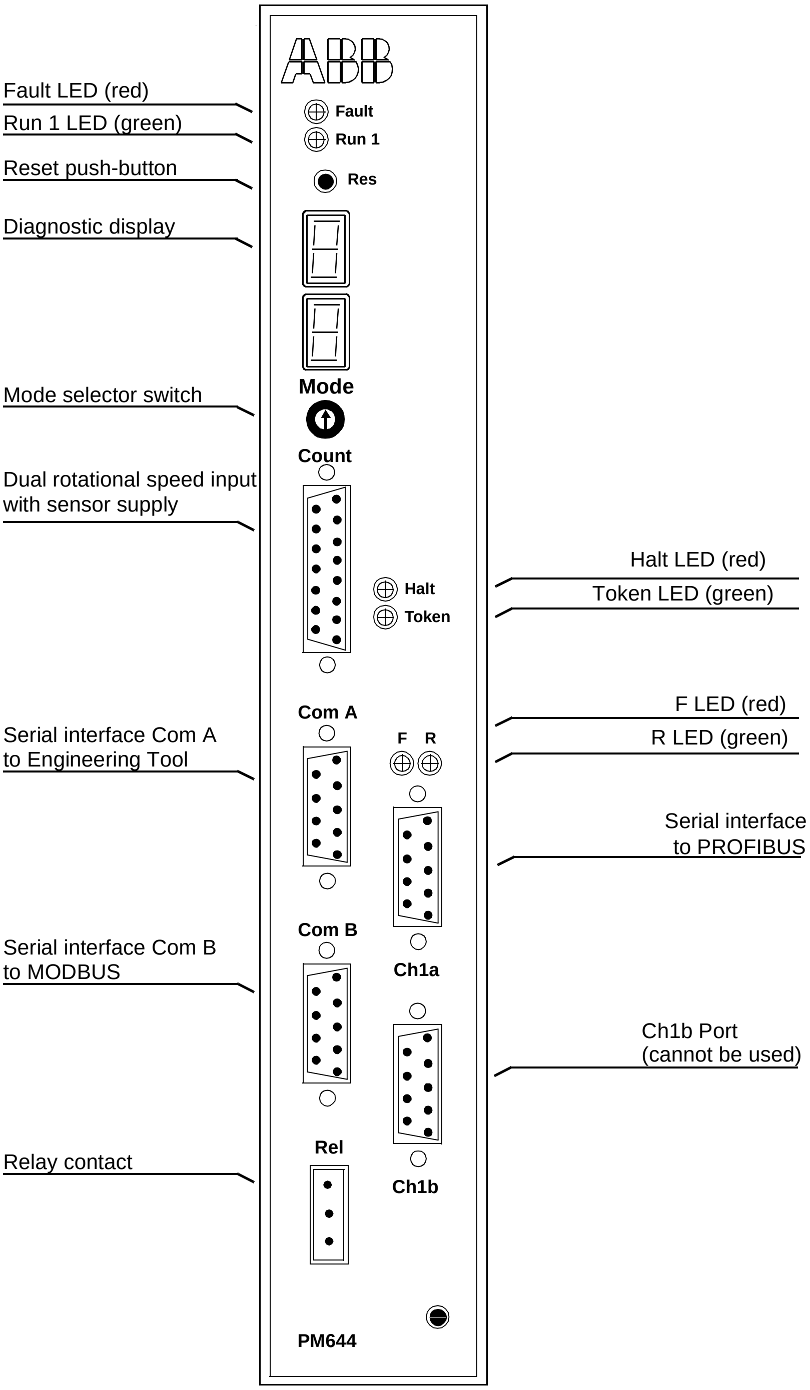


Figure 2-2. PM644 Front View

Functional description

The Processor Module PM644 is based on the 32-bit Motorola MC68360 processor.

The application program and the PROFIBUS communication are processed with separate microprocessors and memories. Diagnostic information and a life sign are exchanged between both microprocessors.

The system software includes diagnostic routines which check the Processor Module PM644 and all used I/O and interface modules during initialization and ensure system integrity during the execution of the application program. Dedicated reactions can be defined within the application program. The system software also monitors whether the Processor Module has sufficient capacity to perform its functions within the times specified. If it does not, the Processor Module inhibits the application. The system software detects when I/O modules are withdrawn. New modules added to the application via the DB elements are initialized automatically.

During power-up, the functions of the Processor Module and the contents of application and system PROM are checked as well as the internal RAM of the Processor Module PM644. While the application program is running, the diagnostic routines continue checking operation without impact on the execution of the application.

Memory

The Processor Module is supplied with a built-in memory. Additionally one module CI630 (or CI626) is necessary in the same controller and used as global memory for communication between the Processor Modules.

The application program is stored in a 1 MByte Flash PROM. The application runs from an SRAM copy of the Flash PROM.

On the Processor Module's processing section (PS), 2 MBytes of SRAM are available.

The SRAM copy of the program permits easy and quick modification and debugging of an application. After modification of an application, you can copy the new version back to the Flash PROM (back up).

For the specific task data exchange via PROFIBUS, the Processor Module additionally contains the communication section (CS) with its own microprocessor and memory. On the communication section 2 MByte Flash PROM for the system software and 2.25 MByte SRAM are available.

The BASE system software and the system software options are loaded via **Com A** on front of the module to the Flash PROM. It is not necessary to replace the Flash PROM or to open the Processor Module. A system software change can be performed directly in the controller on-site.

Backplane

PM644 is to be connected to the multi master backplane. The respective basic subrack RF616 is to be used.

Indication of module status

Six LEDs and a diagnostic display indicate the status of the module.

LED-Status indication

Run 1 LED

The **Run 1** LED is green and indicates that the application program is executing normally.

Fault LED

The **Fault** LED is red and indicates a fault condition on the Processor Module.

Halt LED

The **Halt** LED is red and indicates a halt condition on the PROFIBUS interface processor.

Token LED

The **Token** LED is green and indicates the PROFBUS token.

R(un) LED

The **R** LED is green and indicates that the PROFIBUS interface is configured and operational.

F(ault) LED

The **F** LED is red and indicates that the initialization is running or an error occurred on the PROFIBUS interface.

Diagnostic display

The diagnostic display consists of an upper part and a lower part and indicates:

- Error codes in case of a system stop of the Processor Module

  The LED **Run 1** does not light and "P" is not shown on the diagnostic display.

- Processor Module functions in the system

  The character "P" is always shown in the upper part. A digit or a character which indicates the control mode in accordance with the examples below is shown in the lower part.

The diagnostic display indicates the Processor Module's operating mode as follows:

P– = start-up

P1 = normal operation

P3 = stop after initialization

P4 = Processor Module is not running an application program

P5 = loading application program from PROM

P6 = Engineering Station is connected and is in the on-line mode

PL = waiting for download of system software

PU = loading system software option

xx = error code.

If a two-digit number (xx) is visible, the system has stopped and the number represents an error code.

Res Push-button

Pressing the **Res** push-button initiates a cold start of the Processor Module.

Mode selector

The **Mode** selector has four positions but only position 0 and 1 are used. The mode selector defines the power-up and restart behavior of the Processor Module. If possible, a restart is made automatically after severe error is detected.

Mode 0 (Stop - Mode)

The user can prevent the application program from starting if the mode selector is in position 0. The system software continues execution to allow access to the stored error messages using Advant Station 100 Engineering Station.

Mode 1 (Cold start - Mode)

The initialization procedure starts from the beginning and hardware and software are reset to their initial states. Application software is loaded from the internal PROM into the RAM. The cold start procedure is executed after power-up and after pressing the Res push button.

Serial interface connections Com A and Com B

There are three serial interfaces on the Processor Module:

- Front connector **Com A** to connect Advant Station 100 Engineering Station. Communication speed is fixed at 9600 bit/sec.
- Front connector **Com B** for exchanging data using the optional Modbus protocol with an operator station based on a personal computer. Communication speed is fixed at 9600 bit/sec.
- No parity; 1 Stop Bit, 1 Start Bit.

Relay contact (floating)

The **Rel** contact can be wired in closed-circuit principle (use Pin 1 and Pin 2) or in open-circuit principle (use Pin 3 and Pin 2).

During normal operation with closed-circuit principle the contact is closed. In case of severe errors or during reboot the contact is open.

During normal operation with open-circuit principle the contact is open. In case of severe errors or during reboot the contact is closed.

PROFIBUS connection

With the front connector Ch1a the PROFIBUS can be connected to the PM644. The PROFIBUS interface (according to EN 50170) supports the following features:

- Galvanically separated RS 485 interface (without bus termination)
- Transmission speeds from 9600 Baud up to 12 MBaud
- PROFIBUS-DP master (class 1)
- using of up to 125 PROFIBUS-DP slaves

Rotational speed connection

With the front connector **Count** two incremental inputs with speed measurement and recognition of the direction of the rotation (for example for turbine/drive speed) are available. Each channel includes two RS422 tracks (A and B) for connection of a pulse sensor. The direction of the speed measurement is identified through the phase displacement. Synchronization is not supported.

If the input for recognition of the direction of the speed measurement is not used (B not wired), the PM644 assumes positive direction.

To supply the external sensors two short-circuit-proof 24 V output voltages are available. The outputs are short-circuit and break monitored. The rated current amounts to min. 10 mA and max. 100 mA.

The accuracy of the speed measurement depends on the cycle time of the control task within the application program, which contains the PC element RSM. The length of the cycle time is directly proportional to the measuring accuracy.

Input frequency: max. 40 KHz.

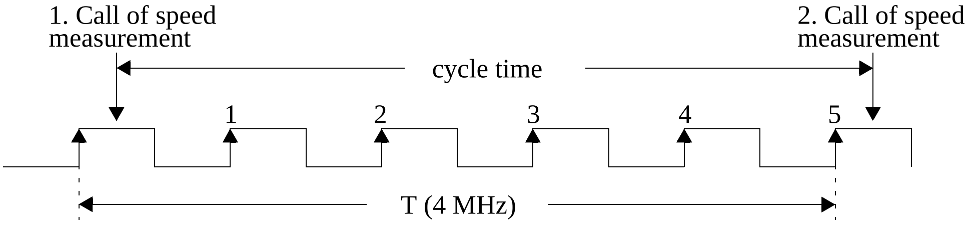


Figure 2-3. Speed Input Pulses versus Time

Only the rising pulses are counted. The speed is calculated via the amount of pulses received within one cycle. Time “T” is measured with 4 MHz, measured from the last pulse in the last cycle until the last pulse in the actual cycle. This is done by the hardware.

If a very slow speed should be measured, the cyclic time in the control module must be less than 4,19 sec. A very slow speed is a speed where not in each cycle a pulse occurs for example with emergency turning gear.

Each incremental sensor channel (1 and 2) including sensor supply reserves 7 contacts of the 15 pin Sub-D-plug on the front of the PM644.

Connector allocation:

Table 2-3. Connector Allocation of Rotational Speed Inputs

PIN	Explanation
1	24 V supply voltage 1+
2	supply voltage 1-
3	incremental sensor input A1+
4	incremental sensor input A1-
5	incremental sensor input B1+
6	incremental sensor input B1-
7	shield
8	not connected
9	24 V supply voltage 2+
10	supply voltage 2-
11	incremental sensor input A2+
12	incremental sensor input A2-
13	incremental sensor input B2+
14	incremental sensor input B2-
15	shield

B.3 PM645

Application

The PM645 is a powerful Processor Module for the AC 160 system for the control and supervision of processes and equipment in power plant environments.

Three different versions of the Processor Module PM645 are existing: PM645A, PM645B and PM645C:

- **PM645A** is used for redundant processing (for example for closed loop control). It does not include speed measurement.
- **PM645B** is used for turbine control applications. It includes redundancy and speed measurement.
- **PM645C** is used for parallel processing with external voting for example for boiler and turbine protection. It includes speed measurement. It does not include redundancy.

Three redundancy configurations are possible:

- 1 out of 2 CPU redundancy
- 1 out of 2 station redundancy and 2 out of 3 station redundancy.

The PM645 can be placed in the positions 3 – 8 of the basic station. In multiprocessing applications up to 6 Processor Modules PM640, PM644, PM645 and PM646 can be placed in one controller. The data communication between these Processor Modules takes place via the global memory in the Communication Interface CI630 (or CI626). The Processor Modules PM645 can be integrated in a configuration for redundant or parallel processing or can be independent from one another. One communication module CI630 (or CI626) is always necessary for the correct operation of the Processor Modules.

Fast data communication between Processor Modules in different controllers or between two Processor Modules in CPU redundancy configuration is provided through two high speed serial link (HSL) connections on front of the PM645.

The Processor Module can be synchronized to an external clock via the minute pulse input on the I/O front connector.

The Processor Module PM645 is based on 32-bit Motorola MC68360 processors.

Module replacement

PM645 can be replaced under voltage, but in case of non redundant configuration process control is interrupted. In case of redundant configuration the other redundant Processor Module(s) continue the process control. After replacement the Processor Module and its assigned I/O channels must be restarted.

Technical data

Table 2-4. PM645 Technical Data

Features	Data
Processor for application program	Motorola MC68360 Microprocessor, 33 MHz (1)
Memory for application program	2 MByte Flash PROM system software 1 MByte Flash PROM application program and boot sector 2 MByte SRAM for application purposes
Processor for HSL communication	Motorola MC68360 Microprocessor, 25 MHz
Memory for HSL communication	512 kByte Flash PROM system software 2 MByte SRAM
Real Time Clock (RTC)	Built in for time and calendar functions
Watchdog	1 software watchdog activated after 10 ms 1 external hardware watchdog activated after 150 ms
COUNT interface	RS422 interface, 15-pin Sub-D, female
Interfaces Com A and Com B	2 RS 232C opto-isolated serial interfaces, V24
Interface connector Com A and Com B	9-pin Sub-D, female (per interface) Section 1: Pin 2 – TxD Pin 3 – RxD Pin 5 – GND
Relay connector	3-pin connector Pin 2 – Common Pin 1 – Normally closed when Processor Module in operational mode Pin 3 – Normally open when Processor Module in operational mode
Relay contact	
Max. voltage	48 V d.c.
Max. current	1.2 A
Max. DC switching power	30 W
Max. contact fuse	1 A, quick-acting

Table 2-4. PM645 Technical Data (Continued)

Features	Data
Interfaces Link 1 and Link 2	RS422 serial interfaces, with HDLC-protocol 3.1 MBaud speed
Interface connector Link 1 and Link 2	Cable for redundancy: TK662, max. length 8 m Cable for protection and general data exchange: TK661, max. length 8 m
I/O port	For minute pulse or event trigger.
	24 V / 1.6 mA Pin-out: Pin 4 – External time synchronization (minute pulse) Pin 5 – Event trigger for a CONTRM; 24 V → 0 V (falling edge) Pin 6 – GND
Power dissipation	< 12 W

(1) Processor Modules without BSE article number are equipped with 25 MHz clock with therefore decreased performance.

Front view

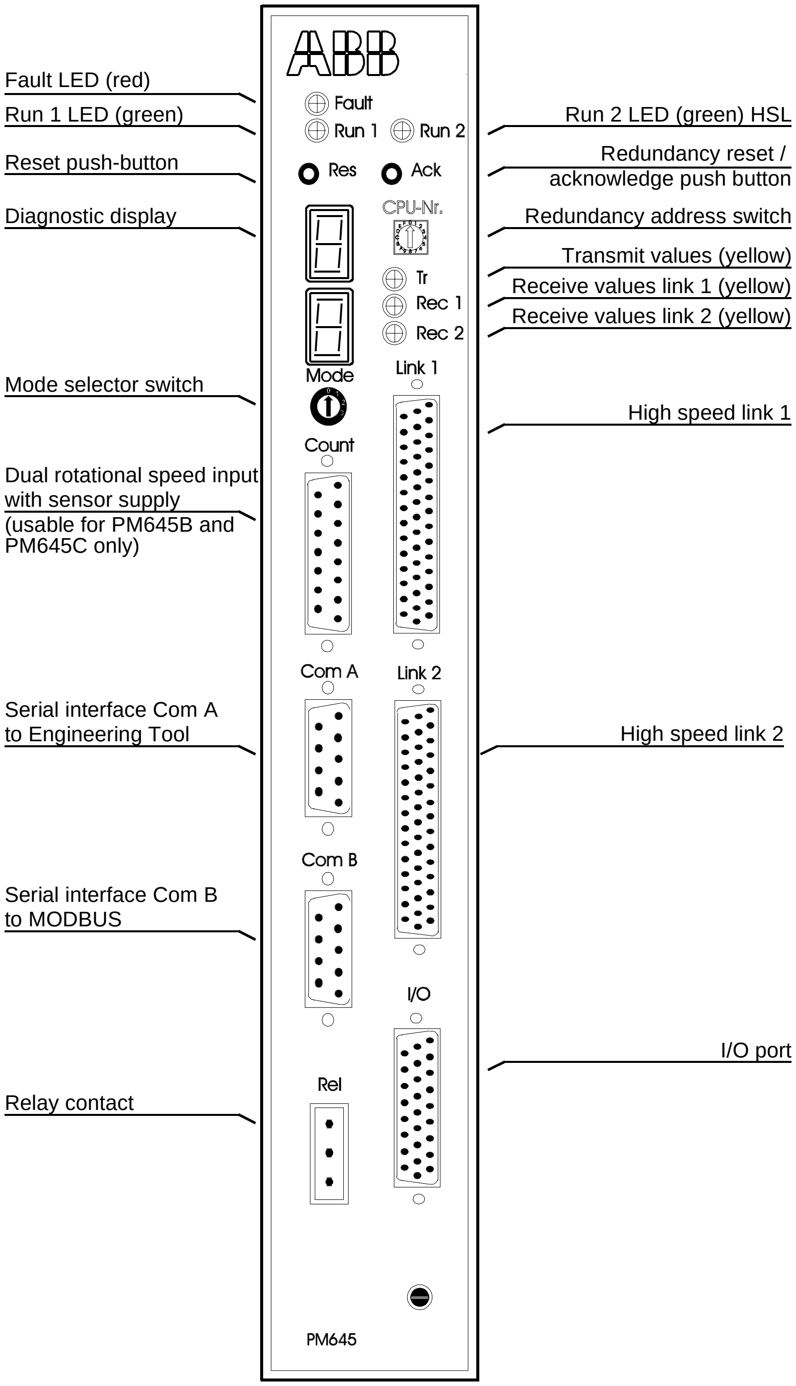

Fault LED (red)
Run 1 LED (green)
Reset push-button
Diagnostic display
Mode selector switch
Dual rotational speed input with sensor supply (usable for PM645B and PM645C only)
Serial interface Com A to Engineering Tool
Serial interface Com B to MODBUS
Relay contact
Run 2 LED (green) HSL
Redundancy reset / acknowledge push button
Redundancy address switch
Transmit values (yellow)
Receive values link 1 (yellow)
Receive values link 2 (yellow)
High speed link 1
High speed link 2
I/O port
ABB
Fault
Run 1
Run 2
Res
Ack
CPU-Nr.
Tr
Rec 1
Rec 2
Mode
Link 1
Count
Com A
Link 2
Com B
I/O
Rel
PM645

Figure 2-4. PM645 Front View

Functional description

The Processor Module PM645 is based on 32-bit Motorola MC68360 processors.

The application program and the HSL communication are processed with separate microprocessors and memories. Diagnostic information and a life sign are exchanged between both microprocessors.

The system software includes diagnostic routines which check the Processor Module PM645 and all used I/O and interface modules during initialization and ensure system integrity during the execution of the application program. Dedicated reactions can be defined within the application program. The system software also monitors whether the Processor Module has sufficient capacity to perform its functions within the times specified. If it does not, the Processor Module inhibits the application. The system software detects when I/O modules are withdrawn. New modules added to the application via the DB elements are initialized automatically.

During power-up, the functions of the Processor Module and the contents of application and system PROM are checked as well as the internal RAM of the Processor Module PM645. While the application program is running, the diagnostic routines continue checking operation without impact on the execution of the application.

The redundancy mode is configurable by the user within the application program for PM645A and PM645B. The configuration is checked during initialization to be correct.

PM645 Versions

Three different versions of the Processor Module PM645 are available (Table 2-5)

Table 2-5. PM645 Versions

Version	Application	Redundancy Voter	Rotational Speed Input	Digital I/O	HSL
PM645A	Redundant processing	Yes	No	Yes	Yes
PM645B	Redundant processing with speed measurement (for example Turbine Control)	Yes	Yes	Yes	Yes
PM645C	Parallel processing with external voting (for example Protection)	No	Yes	Yes	Yes

PM645A and PM645B contain the redundancy voter for system internal voting of the redundant Processor Modules respectively controllers (see Section 3.1.11.3, Redundant Processing with Internal Voting). PM645C doesn't contain the redundancy voter because the voting of the protection channels (Processor Modules or controllers) is to be done externally (see Section 3.1.11.4, Parallel Processing with External Voting).

PM645B and PM645C contain the rotational speed inputs for use within turbine modulating control respectively turbine protection. PM645A is used for standard applications and therefore doesn't contain the rotational speed inputs.

All versions of PM645 contain the HSLs and the digital I/O. The HSLs are used for tracking of redundant Processor Modules through transmission of the tracking values from the master to the slave. The HSLs can also be used for sensor signal exchange between 2 or 3 controllers with redundant or parallel processing or for general signal exchange between several Processor Modules. Thanks to its own microprocessor and memory the HSL communication is autonomous and can operate in parallel to the application program. The digital I/O are all used for redundancy (see paragraph below: I/O connection).

Memory

The Processor Module is supplied with a built-in memory. Additionally one module CI630 (or CI626) is necessary in the same controller. This is used as global memory for communication between the Processor Modules.

The application program is stored in a 1 MByte Flash PROM. The application runs from an SRAM copy of the Flash PROM.

On the Processor Module's processing section (PS), 2 MBytes of SRAM are available.

The SRAM copy of the program permits easy and quick modification and debugging of an application. After modification of an application, you can copy the new version back to the Flash PROM (back up).

For the specific tasks signal exchange via high speed link and redundancy, the Processor Module additionally contains the communication section (CS) with its own microprocessor and memory. On the communication section 512 kByte Flash PROM for the system software and 2 MByte SRAM are available.

The BASE system software and the extended system options are loaded via **Com A** on front of the module to the Flash PROM. It is not necessary to replace the Flash PROM or to open the Processor Module. A software change can be performed directly in the controller on-site.

NOTE

> The PC elements SEQ and STEP cannot be used with redundant processing. Instead the PC elements GRC and P_STEP must be used.

Backplane

PM645 is to be connected to the multi master backplane. The respective basic subrack RF616 is to be used.

Indication of module status

Three LEDs and a diagnostic display indicate the status of the module.

LED-Status indication

Run 1 LED

The **Run 1** LED is green and indicates that the application program is executing normally.

Run 2 LED

The **Run 2** LED is green and indicates that the HSL communication is executing normally.

Fault LED

The **Fault** LED is red and indicates a fault condition on the Processor Module.

Status indication of the diagnostic display

The diagnostic display indicates the Processor Module operating mode:

P– = start-up
P1 = normal operation
P3 = stop after initialization
P4 = CPU is not running an application
P5 = loading application program from PROM
P6 = Engineering Station is connected and is in the on-line mode
PL = waiting for download of system software
PU = loading system software option (enabling options)
xx = error code
b1 = slave, normal operation (only PM645A and PM645B)
bF = slave, not ready for redundancy switchover (only PM645A and PM645B), e.g., failed without HALT or STOP.

If a two-digit number (xx) is visible, the system has stopped and the number represents an error code.

Res push-button

Pressing the **Res** push-button initiates a cold start of the Processor Module.

Ack push-button

Pressing the **Ack** push-button deletes/acknowledges redundancy errors in the Processor Module.
Furthermore the push-button can be used to copy the application program from master to slave in case of CPU redundancy.

Mode selector

The **Mode** selector has four positions but only position 0 and 1 are used. The mode selector defines the power-up and restart behavior of the Processor Module. If possible, a restart is made automatically after a severe error is detected.

Mode 0 (STOP – Mode)

> The user can prevent the application program from starting if the **Mode** selector is in position 0. The system software continues execution to allow access to the stored error messages using Advant Station 100 Engineering Station.

Mode 1 (COLD START– Mode)

> The initialization procedure starts from the beginning and hardware and software are reset to their initial states. Application software is loaded from the internal PROM into the RAM. The cold start procedure is executed after power-up after pressing the **Res** push-button.

CPU-Nr. selector (PM645A and PM645B)

The redundant Processor Modules PM645A or PM645B which belong to a common redundant configuration are internally distinguished by the CPU number. The input is done by the **CPU-Nr.** selector. The numbers have to start with 1 and must be in consecutive order without gap. Only the numbers 1 to 3 are available. In case of non-redundant configurations the **CPU-Nr.** selector has to be set to position 0.

Serial interface connections Com A and Com B

There are two serial interfaces on the Processor Module:

- Front connector **Com A** to connect Advant Station 100 Engineering Station programming tool. Communication speed is fixed at 9600 bit/sec.
- Front connector **Com B** for exchanging data using the optional Modbus protocol with an operator station based on a personal computer. Communication speed is fixed at 9600 bit/sec.
- No parity; 1 Stop Bit, 1 Start Bit

Relay contact (floating)

The contact can be wired in closed-circuit principle (use Pin 1 and Pin 2) or in open-circuit principle (use Pin 3 and Pin 2).

During normal operation with closed-circuit principle the contact is closed. In case of severe errors or during reboot the contact is open.

During normal operation with open-circuit principle the contact is open. In case of severe errors or during reboot the contact is closed.

The relay contact also reacts, if the input MAXRPM (overspeed input) of the PC element RSM is activated. This is provided automatically without any additional planning.

Link 1 and Link 2 connections

Two communication links are provided as high speed serial links (HSLs). Values are sent out in parallel via link 1 and link 2 to the PM645 partner modules. Different values are received via link 1 and link 2 from up to two different PM645 partner modules (signalled via LED **Rec 1** and **Rec 2**).

The receive and transmit channels are serial RS 485 channels with HDLC protocol, the speed is 3.1 MBaud on each channel. Different cables are required for connection: one cable-type TK661 for operation for data exchange and another cable type TK662 for operation with redundancies.

I/O port connections

Digital input/output interface for 24 V d.c. digital inputs and 100 mA digital output. The outputs are output stage monitored and short circuit protected. The inputs are filtered.

Some I/O are predefined and reserved for redundancy:

- For station redundancy (see Section 3.1.11.3, Redundant Processing with Internal Voting) the selector switches 89AU01 and 89AL01 get commands from the Processor Modules and provide check back signals to the Processor Modules.
- The Processor Modules provide a trip signal if all Processor Modules are failed in order to allow shut down of the process.

For the redundancy I/O connection the cable 3BDS 100 575 can be used.

Other predefined signals:

- External minute pulse input to synchronize the time.
- Event for triggering a CONTRM.

Predefined Pin-Out for I/O Port

Table 2-6. Predefined Pin-Out for I/O Port

Signal	26 Pin I/O Port
Event Trigger for a CONTRM (24 V → 0 V)	Pin 5
External Timesync (minute pulse)	Pin 4
GND	Pin 6

Rotational speed connection (PM645B and PM645C)

With the front connector COUNT two incremental inputs with speed measurement and recognition of the direction of the rotation (for example for turbine/drive speed) are available. Each channel includes two RS422 tracks (A and B) for connection of a pulse sensor. The direction of the speed measurement is identified through the phase displacement. Synchronization is not supported.

If the input for recognition of the direction of the speed measurement is not used (B not wired), the PM645 assumes positive direction.

To supply the external sensors two short-circuit-proof 24 V output voltages are available. The outputs are short-circuit and break monitored. The rated current amounts to min. 10 mA and max. 100 mA.

The accuracy of the speed measurement depends on the cycle time of the control task within the application program, which contains the PC element RSM. The length of the cycle time is directly proportional to the measuring accuracy.

Input frequency: max. 40 KHz.

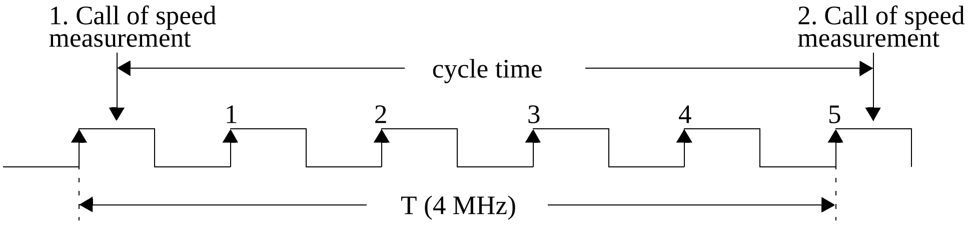


Figure 2-5. Speed Input Pulses versus Time

Only the rising pulses are counted. The speed is calculated via the amount of pulses received within one cycle. Time "T" is measured with 4 MHz, measured from the last pulse in the last cycle until the last pulse in the actual cycle. This is done by the hardware.

If a very slow speed should be measured, the cyclic time in the control module must be less than 4,19 sec. A very slow speed is a speed where not in each cycle a pulse occurs for example with emergency turning gear.

Each incremental sensor channel (1 and 2) including sensor supply reserves 7 contacts of the 15 pin Sub-D-plug on the front of the PM645B and PM645C.

Connector allocation:

Table 2-7. Connector Allocation of Rotational Speed Inputs

PIN	Explanation
1	24 V supply voltage 1+
2	supply voltage 1-
3	incremental sensor input A1+
4	incremental sensor input A1-
5	incremental sensor input B1+
6	incremental sensor input B1-
7	shield
8	not connected
9	24 V supply voltage 2+
10	supply voltage 2-
11	incremental sensor input A2+
12	incremental sensor input A2-
13	incremental sensor input B2+
14	incremental sensor input B2-
15	shield

B.4 PM646

Application

The PM646 is a powerful Processor Module for the AC 160 system for the control and supervision of processes and equipment in power plant environments.

The Processor Modules PM646 can be integrated in a configuration for redundant or parallel processing or can be independent from one another. PM646 mainly is used for parallel processing with external voting especially for safety applications (e.g. boiler protection).

But all prerequisites for internal voting are also available and redundancy configurations might be realized, too:

- 1 out of 2 CPU redundancy
- 1 out of 2 station redundancy and 2 out of 3 station redundancy.

The module PM646 differs from PM645 concerning several hardware components:

- Redundant data storage in SRAM (Mirror-RAM) with hardware comparator.
- Additional hardware watchdog for supervision of triggering from system software on both module sections. These watchdog outputs are combined to a common trigger for the relay.
- Extended (over-) voltage supervision of the 5 V power supply.
- PM646 does not include speed measurement.

The PM646 can be placed in the positions 3 to 8 of the basic station. In multiprocessing applications up to 6 Processor Modules PM640, PM644, PM645 and PM646 can be placed in one controller. The data communication between these Processor Modules takes place via the global memory in the Communication Interface CI630 (or CI626). One communication module CI630 (or CI626) is always necessary for the correct operation of the Processor Modules.

Fast data communication between Processor Modules in different controllers or between two Processor Modules in CPU redundancy configuration is provided through two high speed serial link (HSL) connections on front of the PM646.

The Processor Module can be synchronized to an external clock via the minute pulse input on the I/O front connector.

The Processor Module PM646 is based on 32-bit Motorola MC68360 processors.

Module replacement

PM646 can be replaced under voltage, but in case of non-redundant configuration process control is interrupted. In case of redundant configuration the other redundant Processor Module(s) continue the process control. After replacement the Processor Module and its assigned I/O channels must be restarted.

Technical data

Table 2-8. PM646 Technical Data

Features	Data
Processor for application program	Motorola MC68360 Microprocessor, 33 MHz
Memory for application program	2 MByte Flash PROM system software 1 MByte Flash PROM application program and boot sector 2 MByte SRAM for application purposes—extended with a 2 MByte Mirror-SRAM for redundant data storage and hardware comparison
Processor for HSL communication	Motorola MC68360 Microprocessor, 25 MHz
Memory for HSL communication	512 kByte Flash PROM system software 2 MByte SRAM
Real Time Clock (RTC)	Built in for time and calendar functions
Watchdogs	1 software watchdog activated after 10 ms 1 external hardware watchdog activated after 150 ms (not used) 2 external hardware watchdogs (protection watchdogs) for supervision of periodic triggering within a narrow trigger window and output to the on-board relay (responding outside trigger window 7 ms < > 10 ms) Watchdogs available on both processor boards.
Interfaces Com A and Com B	2 RS 232C opto-isolated serial interfaces, V24
Interface connector Com A and Com B	9-pin Sub-D, female (per interface) Section 1: Pin 2 – TxD Pin 3 – RxD Pin 5 – GND
Relay activation	The on-board relay is a central part of the so called “Second Shutdown Path” and combines supervision functions on both processor boards to a common bypass switch for the output modules

Table 2-8. PM646 Technical Data (Continued)

Features	Data
Relay connector	3-pin connector Pin 2 – Common Pin 1 – Normally closed when Processor Module in operational mode Pin 3 – Normally open when Processor Module in operational mode
Relay contact	
Max. voltage	48 V d.c.
Max. current	1.2 A
Max. DC switching power	30 W
Max. contact fuse	1 A, quick-acting
Interfaces Link 1 and Link 2	RS 422 serial interfaces, with HDLC-protocol 3.1 MBaud speed
Interface connector Link 1 and Link 2	Cable for redundancy: TK662, max. length 8 m Cable for protection and general data exchange: TK661, max. length 8 m
I/O port	For minute pulse or event trigger.
	24 V / 1.6 mA Pin-out: Pin 4 – External time synchronization (minute pulse) Pin 5 – Event trigger for a CONTRM; 24 V → 0 V (falling edge) Pin 6 – GND
Power dissipation	< 12 W

Front view

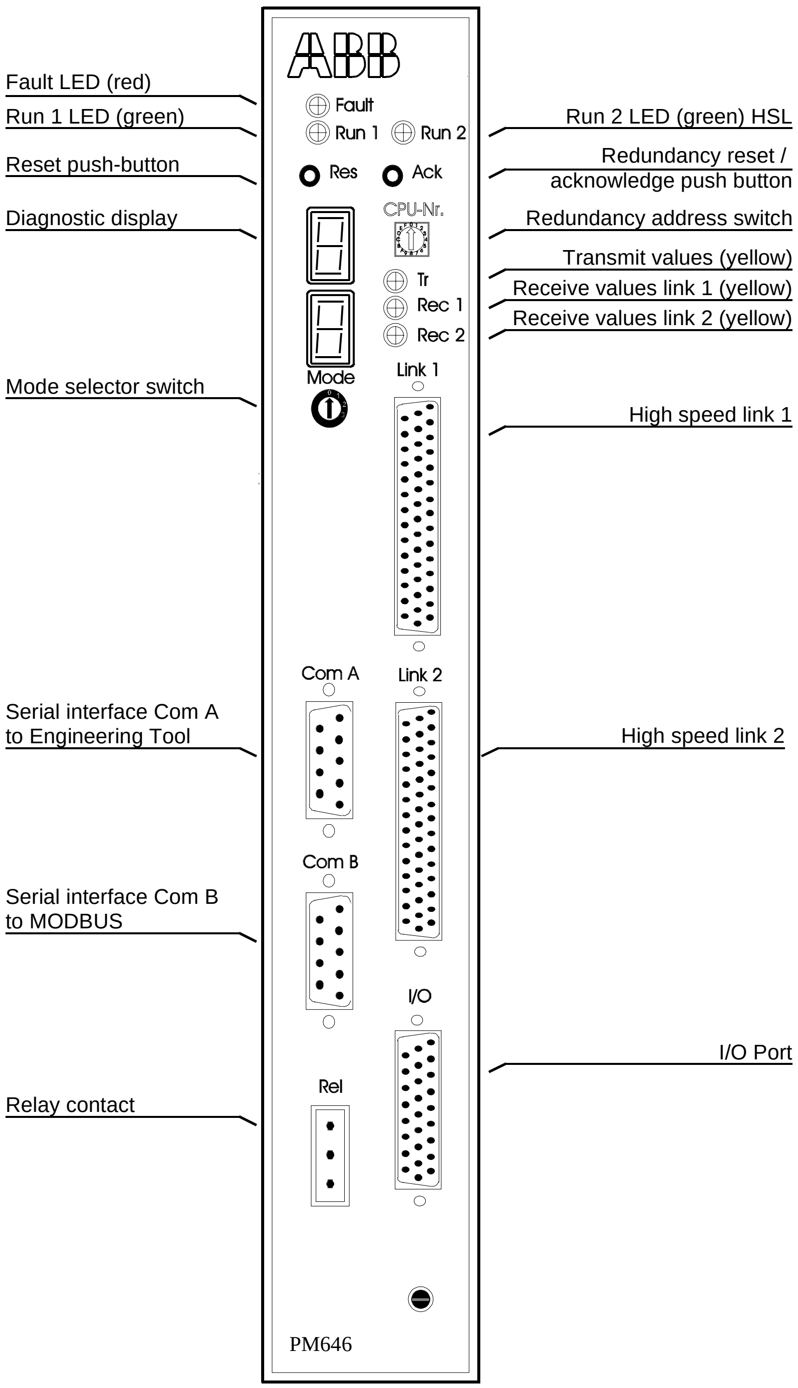


Figure 2-6. PM646 Front View

Functional description

The Processor Module PM646 is based on 32-bit Motorola MC68360 processors.

The application program and the HSL communication are processed with separate microprocessors and memories. Diagnostic information and a life sign are exchanged between both microprocessors.

The system software includes diagnostic routines which check the Processor Module PM646 and all used I/O and interface modules during initialization and ensure system integrity during the execution of the application program. Dedicated reactions can be defined within the application program. The system software also monitors whether the Processor Module has sufficient capacity to perform its functions within the times specified. If it does not, the Processor Module inhibits the application. The system software detects when I/O modules are withdrawn. New modules added to the application via the DB elements are initialized automatically.

The redundancy mode is configurable by the user within the application program for PM646. The configuration is checked during initialization to be correct.

Safety functionality

During power-up, the functions of the Processor Module and the contents of application and system PROM are checked as well as the internal RAM of the Processor Module PM646. While the application program is running, the diagnostic routines continue checking operation without impact on the execution of the application.

All hardware monitoring and other central hardware components of the PM646 will be checked completely within a short time period (< 3 s) in order to secure their regular function at any time. These tests include the fault detection as well as the corresponding path for the safety response.

The self-test functions include:

- Detection of data falsification between the redundant SRAM
- Detection of inadmissible trigger periods for the CPU watchdog, supervised trigger window: 8 ms ±25%
- Test of the CPU instruction set
- Test of all HSL related components (CPUs, Memory, etc.) by transferring of redundant data buffers (inverted data representation) with validations at several locations of the communication link
- Test of the dual ported memory between both Processor Module sections
- Monitoring one another between both microprocessors by exchanging life signs

Further safety measures are (only available in 2 out of 3 parallel processing):

- Cyclically tests of the I/O modules channels
  (special I/O modules—AX646 and DX610—and PC elements required)
- Synchronization for output test between parallel controllers via token mechanism
- The PM646 provides an independent second shutdown path to guarantee a safe shutdown

of the relay outputs (DX610) in case of a severe error detected on hard- or software level.

PM646 Versions

Only one version of the Processor Module PM646 is available (Table 2-9)

Table 2-9. PM646 Version

Version	Application	Redundancy Voter	Rotational Speed Input	Digital I/O	HSL
PM646	Parallel processing with external voting and Redundant processing	Yes	No	Yes	Yes

PM646 mainly is used for safety applications and the voting of the protection channels (Processor Modules or controllers) is to be done externally (see Section 3.1.11.4, Parallel Processing with External Voting). But it also contains the redundancy voter for system internal voting of the redundant Processor Modules respectively controllers (see Section 3.1.11.3, Redundant Processing with Internal Voting).

Because of the main use for safety applications the PM646 doesn’t support rotational speed measurement via front connector.

The PM646 contains the HSLs and the digital I/O. The HSLs are used for tracking of redundant Processor Modules through transmission of the tracking values from the master to the slave. The HSLs can also be used for sensor signal exchange between 2 or 3 controllers with redundant or parallel processing or for general signal exchange between several Processor Modules. Thanks to its own microprocessor and memory the HSL communication is autonomous and can operate in parallel to the application program. The digital I/O are all used for redundancy (see paragraph below: I/O connection).

Memory

The Processor Module is supplied with a built-in memory. Additionally one module CI630 (or CI626) is necessary in the same controller. This is used as global memory for communication between the Processor Modules.

The application program is stored in a 1 MByte Flash PROM. The application runs from an SRAM copy of the Flash PROM.

On the Processor Module’s processing section (PS), 2 MBytes of SRAM are available.

The SRAM copy of the program permits easy and quick modification and debugging of an application. After modification of an application, you can copy the new version back to the Flash PROM (back up).

For the specific tasks signal exchange via high speed link and redundancy, the Processor Module additionally contains the communication section (CS) with its own microprocessor and memory. On the communication section 512 KByte Flash PROM for the system software and 2 MByte SRAM are available.

The BASE system software and the extended system options are loaded via **Com A** on front of the module to the Flash PROM. It is not necessary to replace the Flash PROM or to open the Processor Module. A software change can be performed directly in the controller on-site.

NOTE

The PC elements SEQ and STEP cannot be used with redundant processing.
Instead the PC elements GRC and P_STEP must be used.

Backplane

PM646 is to be connected to the multi master backplane. The respective basic subrack RF616 is to be used.

Indication of module status

Three LEDs and a diagnostic display indicate the status of the module.

LED-Status indication

Run 1 LED

The **Run 1** LED is green and indicates that the application program is executing normally.

Run 2 LED

The **Run 2** LED is green and indicates that the HSL communication is executing normally.

Fault LED

The **Fault** LED is red and indicates a fault condition on the Processor Module.

Status indication of the diagnostic display

The diagnostic display indicates the Processor Module operating mode:

P– = start-up

P1 = normal operation

P3 = stop after initialization

P4 = Processor Module is not running an application

P5 = loading application program from PROM

P6 = Engineering Station is connected and is in the on-line mode

PL = waiting for download of system software

PU = loading system software option (enabling options)

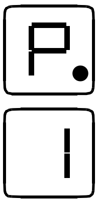
xx = error code

b1 = slave, normal operation

bF = slave, not ready for redundancy switchover, e.g., failed without HALT or STOP.

If a two-digit number (xx) is visible, the system has stopped and the number represents an error code.

The PM646 indicates further status information using the dots of the diagnostic display:



= test token (*) available on local controller

(*) Between parallel controllers a token mechanism is provided to synchronize the test of the relay output modules

Res push-button

Pressing the **Res** push-button initiates a cold start of the Processor Module.

Ack push-button

Pressing the **Ack** push-button deletes/acknowledges redundancy errors in the Processor Module.
Furthermore the push-button can be used to copy the application program from master to slave in case of CPU redundancy.

Mode selector

The **Mode** selector has four positions but only position 0 and 1 are used. The mode selector defines the power-up and restart behavior of the Processor Module. If possible, a restart is made automatically after a severe error is detected.

Mode 0 (STOP – Mode)

> The user can prevent the application program from starting if the MODE selector is in position 0. The system software continues execution to allow access to the stored error messages using Advant Station 100 Engineering Station.

Mode 1 (COLD START – Mode)

> The initialization procedure starts from the beginning and hardware and software are reset to their initial states. Application software is loaded from the internal PROM into the

RAM. The cold start procedure is executed after power-up after pressing the RES push-button.

CPU-Nr. selector

The redundant Processor Modules PM646 which belong to a common redundant configuration are internally distinguished by the CPU number. The input is done by the **CPU-Nr.** selector. The numbers have to start with 1 and must be in consecutive order without gap. Only the numbers 1–3 are available.
In case of non-redundant configurations the **CPU-Nr.** selector has to be set to position 0.

Serial interface connections Com A and Com B

There are two serial interfaces on the Processor Module:

- Front connector **Com A** to connect Advant Station 100 Engineering Station. Communication speed is fixed at 9600 bit/sec.
- Front connector **Com B** for exchanging data using the optional Modbus protocol with an operator station based on a personal computer. Communication speed is fixed at 9600 bit/sec.
- No parity; 1 Stop Bit, 1 Start Bit.

Relay contact (floating)

The **Rel** contact can be wired in closed-circuit principle (use Pin 1 and Pin 2) or in open-circuit principle (use Pin 3 and Pin 2).

During normal operation with closed-circuit principle the contact is closed. In case of severe errors or during reboot the contact is open.

During normal operation with open-circuit principle the contact is open. In case of severe errors or during reboot the contact is closed.

Link 1 and Link 2 connections

Two communication links are provided as high speed serial links (HSLs). Values are sent out in parallel via **Link 1** and **Link 2** to the PM646 partner modules. Different values are received via **Link 1** and **Link 2** from up to two different PM646 partner modules (signalled via LED **Rec 1** and **Rec 2**).

The receive and transmit channels are serial RS 485 channels with HDLC protocol, the speed is 3.1 MBaud on each channel. Different cables are required for connection: one cable-type TK661 for operation for data exchange and another cable-type TK662 for operation with redundancies.

I/O port connection

Digital input/output interface for 24 V d.c. digital inputs and 100 mA digital output. The outputs are output stage monitored and short circuit protected. The inputs are filtered.

Some I/O are predefined and reserved for redundancy:

- For station redundancy (see Section 3.1.11.3, Redundant Processing with Internal Voting) the selector switches 89AU01 and 89AL01 get commands from the Processor Modules and provide check back signals to the Processor Modules.
- The Processor Modules provide a trip signal if all Processor Modules are failed in order to allow shut down of the process.

For the redundancy I/O connection the cable 3BDS 100 575 can be used.

Other predefined signals:

- External minute pulse input to synchronize the time.
- Event for triggering a CONTRM.

Predefined Pin-Out for I/O Port

Table 2-10. Predefined Pin-Out for I/O Port

Signal	26 Pin I/O Port
Event Trigger for a CONTRM (24 V → 0 V)	Pin 5
External Timesync (minute pulse)	Pin 4
GND	Pin 6

Appendix C Cabinet Configuration

C.1 Single Cabinet Configuration

The figure below shows two single cabinet configurations depending on kind of power supply. You can use power supply unit SA610 or SA161 (input a.c. 120 V) / SA162 (input a.c. 230 V).

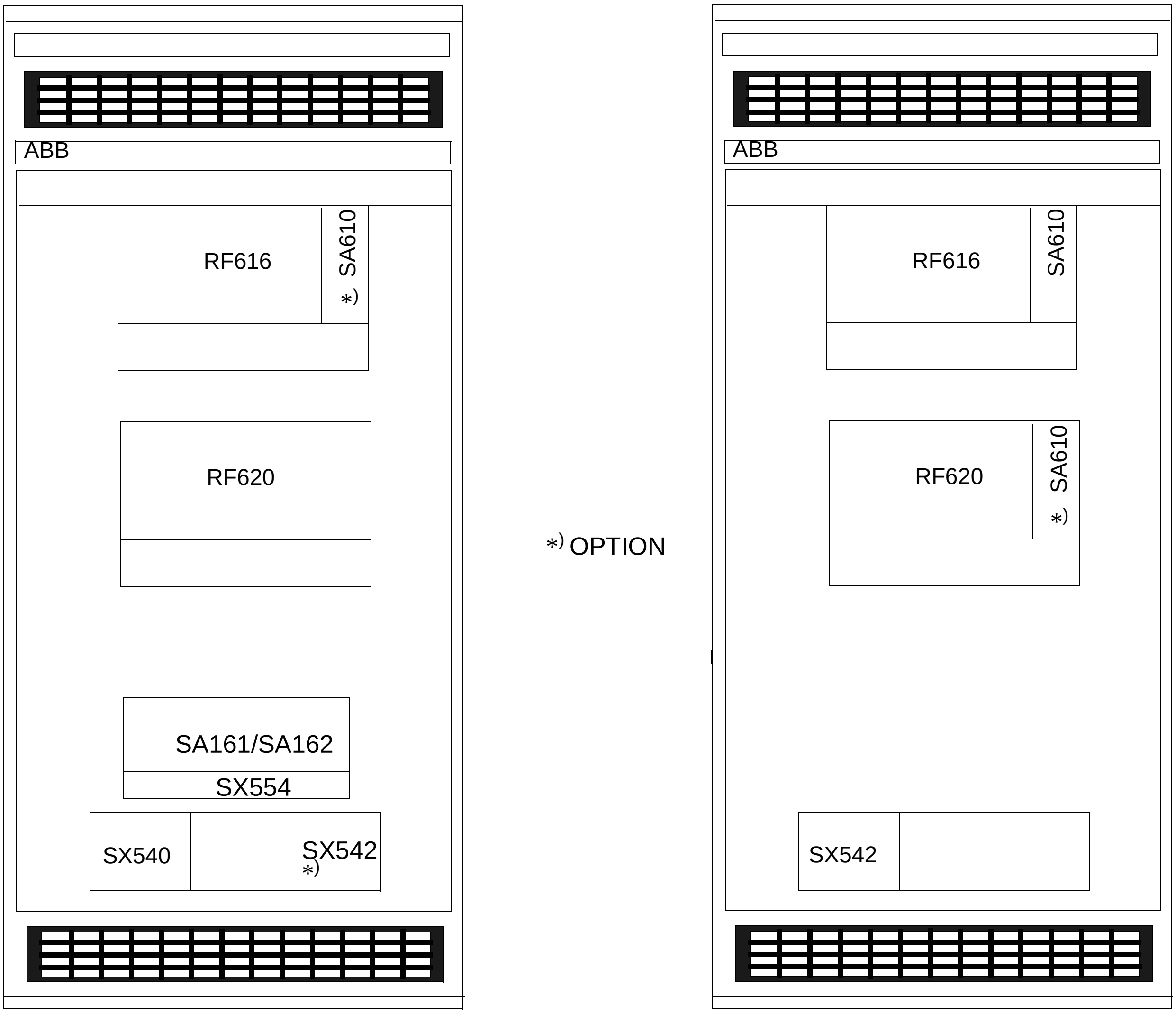


Figure 3-1. Single Cabinet Configuration with Different Kinds of Power Supply

Please see Section C.3, Power Supply Units SA16x and SA17x for technical data of SA16x and Section C.4, Distribution Units for Cabinets for description of distribution units SX540, SX542 and SX554.

For information about SA610 please see *S600 I/O Hardware Reference Manual*.

C.2 Maximum Cabinet Configuration

The figure below shows a block diagram of a maximum cabinet configuration using a central power supply unit SA161 (input a.c. 120 V) or SA162 (input a.c. 230 V).

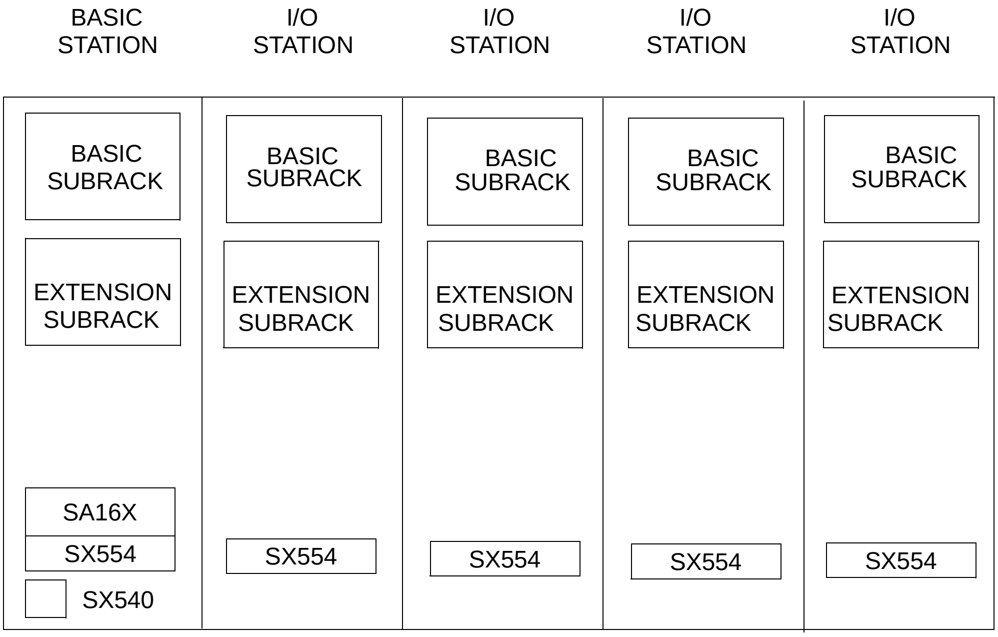


Figure 3-2. Maximum Cabinet Configuration with Central Power Supply

Please see Section C.3, Power Supply Units SA16x and SA17x for technical data of SA16x and Section C.4, Distribution Units for Cabinets for description of distribution units SX540 and SX554.

The figure below shows a block diagram of a maximum cabinet configuration using a decentralized power supply. In station one power supply unit SA610 is used.

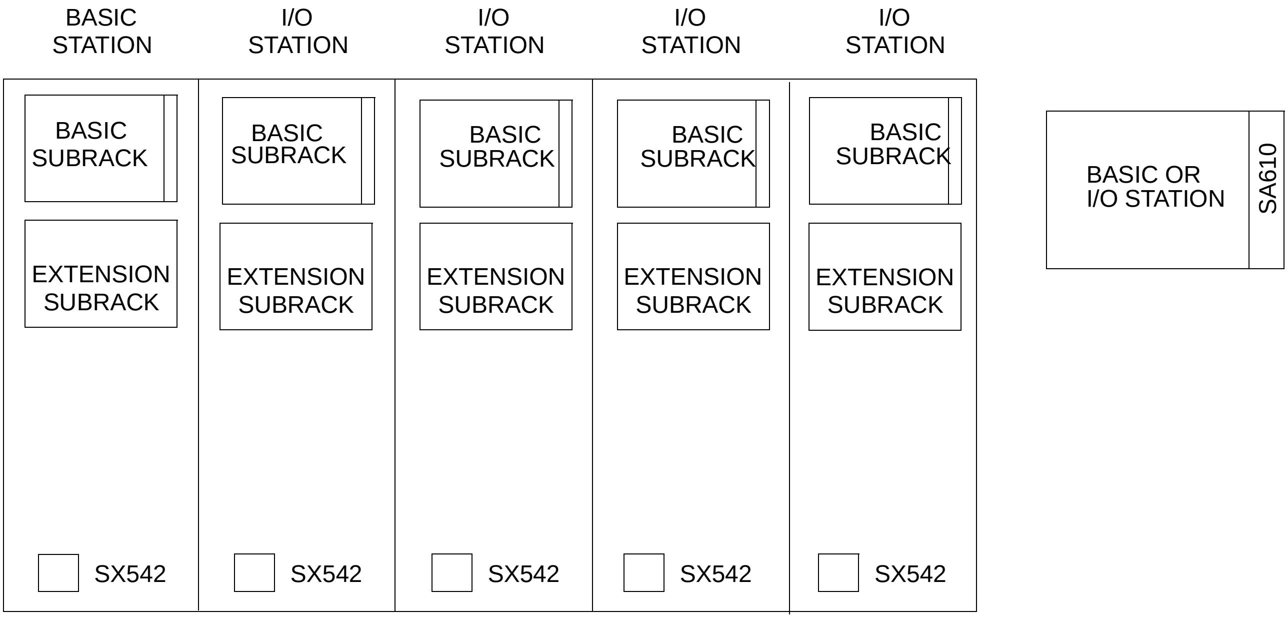


Figure 3-3. Maximum Cabinet Configuration with Decentralized Power Supply

Please see *S600 I/O Hardware Reference Manual* for technical data of SA610 and Section C.4, Distribution Units for Cabinets for description of distribution unit SX542.

C.3 Power Supply Units SA16x and SA17x

Table 3-1. Overview Technical Data for Power Supply SA16x and SA17x

Type of Power Supply	Description	Input	Output
SA161	Power supply for Advant Controller 160 and for field equipment.	a.c. 120 V	d.c. 24 V, 10 A
SA162	Power supply for Advant Controller 160 and for field equipment.	a.c. 230 V	d.c. 24 V, 10 A
SA171	Power supply for field equipment.	a.c. 120 V	d.c. 48 V, 5 A
SA172	Power supply for field equipment.	a.c. 230 V	d.c. 48 V, 5 A

C.4 Distribution Units for Cabinets

Table 3-2. List of Distribution Units

Type of Distribution Unit	Description
SX540	Power switch and distribution unit, a.c. 250 V, 35 A
SX542	Power distribution unit, a.c. 250 V, 20 A
SX554	Distribution unit, d.c. 60 V, 430 A

The figures below show the circuit diagrams of the distribution units listed in Table -2 (???).

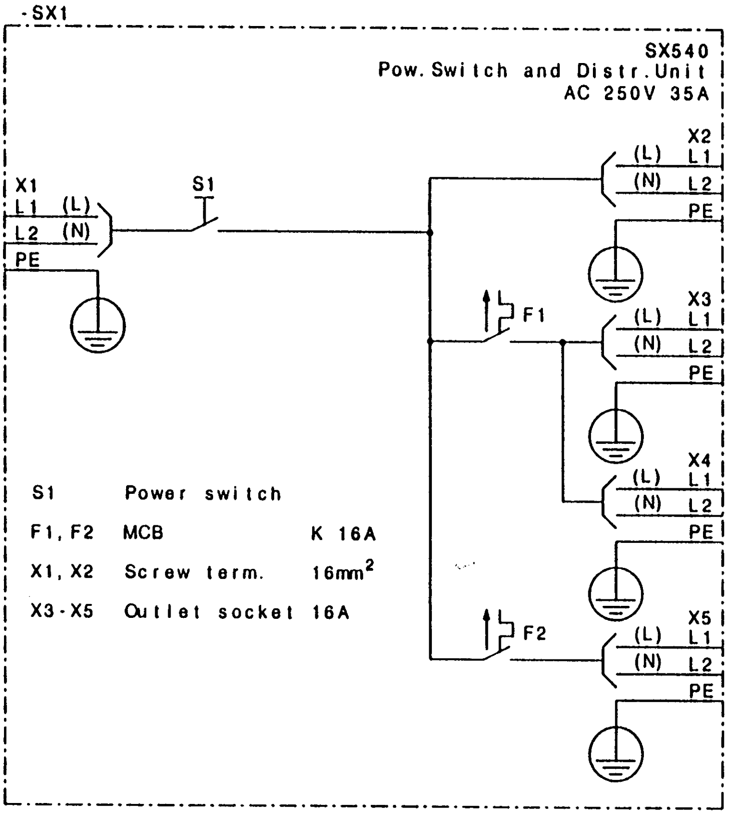


Figure 3-4. Circuit Diagram of Distribution Unit SX540

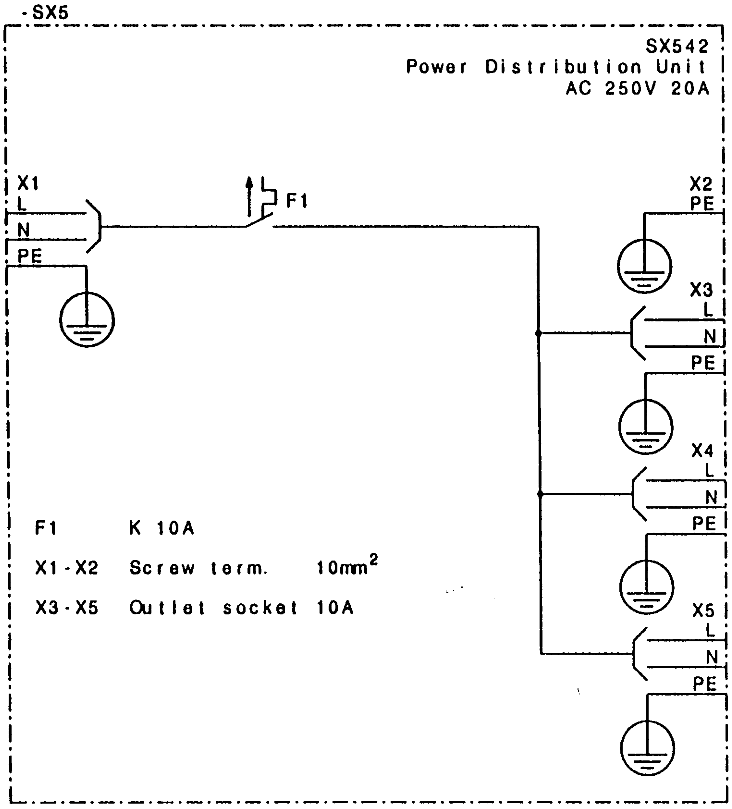
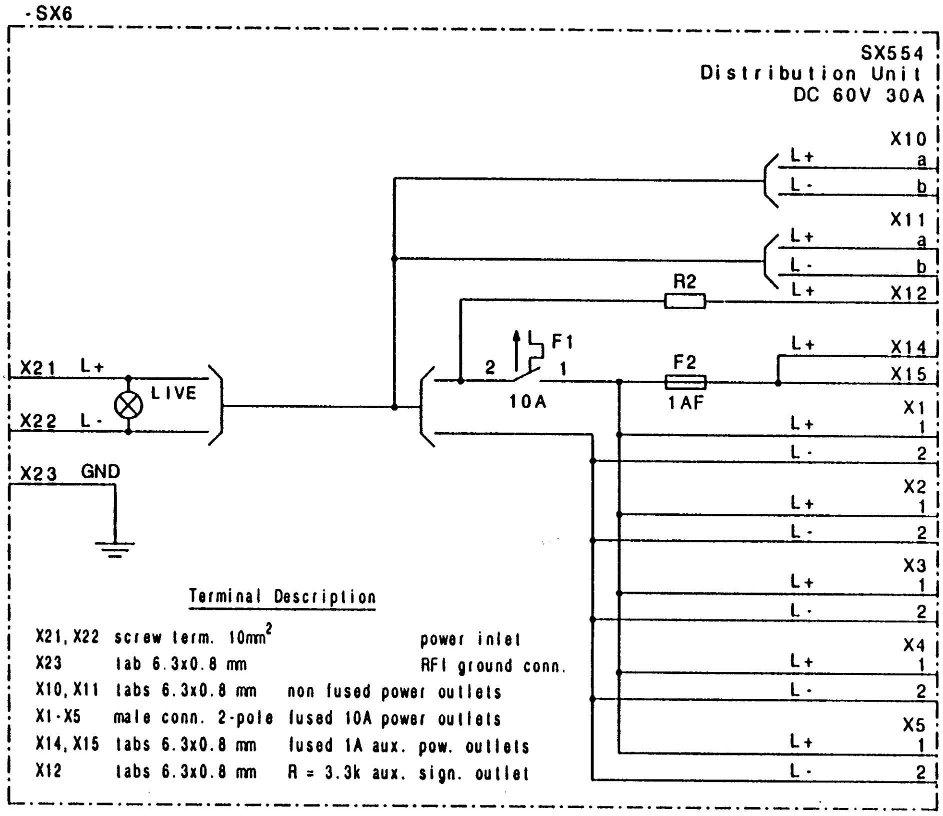


Figure 3-5. Circuit Diagram of Distribution Unit SX542



Terminal Description

X21, X22	screw term. 10mm^2	power inlet
X23	tab 6.3x0.8 mm	RFI ground conn.
X10, X11	tabs 6.3x0.8 mm	non fused power outlets
X1-X5	male conn. 2-pole	fused 10A power outlets
X14, X15	tabs 6.3x0.8 mm	fused 1A aux. pow. outlets
X12	tabs 6.3x0.8 mm	R = 3.3k aux. sign. outlet

Figure 3-6. Circuit Diagram of Distribution Unit SX554

Appendix D Delivery Documentation

D.1 Delivery Binder Content

As a complement to the user documentation, there is a binder which contains other pertinent documentation related to the delivery. This pertinent documentation is referred to as the **Delivery Binder**.

The Delivery Binder has the same content structure for all Advant products.

The Delivery Binder includes the following documents:

Order Reference Sheet
A document which contains the ABB order reference number. This number serves as the basis for all subsequent references to this delivery.

Delivered Version Specification
A document which contains the general system release information.

System Log
This is a series of blank forms suitable for logging hardware and software repairs, modifications or expansions of the product. These forms are used by the service engineers in the initial commissioning as well as by customers after delivery from ABB.

Delivery Specification
The information in this document specifies all parts of value which are included in the initial delivery (the actual List of Apparatus).
When subsequent changes to the product occur, the list of new parts is included here, too.

License Certificate
This certificate is the end user's evidence that he has purchased the right to use the specified (software) products. The document contains the end user name and a list of the particular software packages under license, as well a list of our standard terms and conditions.

Inspection and Test Record
This document, filled in by the production department, specifies which test specifications and delivery test procedures the equipment has been subject to.

Release Notes
Latest product information which is not covered by the standard user documentation.

Terminal Diagram
A block diagram where all hardware modules (circuit boards and units) are represented by functional symbols and where all interconnections between the modules are shown.
The diagram is mainly used at installation, commissioning and system maintenance (fault finding).

Support and Problem Reporting
Includes information and instructions on how to get support from ABB and how to report problems with the product and its functions. Forms are available for problem reporting.

INDEX

Numerics
3964R 170, 227
89AR30 202
89RT01 117
A
AC 110 12
AC 160
  block diagram 132, 133, 134, 135
  configuration with I/O extension 161, 162
  differences compared with AC 110 12
  interfaces 136
AC 450 212, 214
AdvaSoft for Windows 30, 187, 230
AF 100 163
  coaxial cable 165
  main bus 165
  optical cable 164
  subordinate bus 165
  twisted pair 164
AMPL 32, 174
  application program 176
Analog
  I/O Calibration 306
  Input/Output 150
  Inputs 89, 148
  Outputs 149
Application Program
  capacity 228
  execution 251
  structure 250
B
Base System Software 26
Basic Station 144
  configuration 35
  position disposition 233
Basic units 5, 20
Boiler Protection 202
bus terminator 173
C
Cabinet 18
  Configuration 349
  Dimensions 230
  erection 52
  protection class 231
  radio-proof 66
Cables
  GKWE 602 635 197
  TK610 74
  TK612 35
  TK615 35
  TK630 79
  TK640 79
  TK661 201, 202
  TK662 195, 197
CE-marking 39
Checklists 93
CI532 88
CI610 73, 144
CI615 73, 144
CI626 163, 166
CI626V1 163
CI627 163, 166
CI630 35, 163, 166
CI631 163, 166
COLD START-Mode 109, 241
Communication interface modules
  CI626 163, 166
  CI626V1 163
  CI627 163, 166
  CI630 35, 163, 166
  CI631 163, 166
Communication links 32
Configuration 22
CPU load 221, 222
D
DataSet Peripheral DSP 227
DB part 248, 250
DCF77 212
DI685 151
Diagnostic Display 242, 245, 265

INDEX (continued)

Diagnostics 283
Digital
  Inputs 150
  Outputs 151
DSP 227
E
Electromagnetic compatibility
  EMC 39, 231
EMC 39, 231
Emergency Shut-down 99
Engineering Station, connection 109
Error
  Codes 265
  Report 261, 271
  Texts 271
Executable Unit 251
F
Fault Tracing 285
Field power supply 139, 351
Forcing
  DB part 116
  PC part 115
G
Grounding 42, 57
H
Hardware 20
Heat Dissipation 188
High speed serial link HSL 167
High Voltage Switch-gear 46
Historical values 167
HSL 167
  configuration 207
I
I/O Bus
  extender modules
    CI610 73, 144
    CI615 73, 144
  Extension 73, 159
I/O extension bus 144
I/O interface cables GKWE 602 635 197
I/O station 144
  position disposition 234
L
Lightning Strike Protection 46
Load System Software 104
M
Memory 25
minute pulse 212
  AC 160 213
  AC 450 214
MODBUS 29, 171, 227
Modems
  TC513 164
  TC514 164
  TC515 164
  TC630 164
Multivendor interfaces
  3964R 170, 227
  CI532 88
  MODBUS 171, 227
  RCOM 169, 227
O
Off-line program change 117, 119
On-line program change 114, 117, 119
Operator interface 183, 229
  AdvaSoft for Windows 230
OPT1 29
OPT12 29
OPT2 28
OPT3 28
OPT4 29
OSP 102
Output set predetermined
  OSP 102
P
Parallel Processing 199, 201
Parallel Processor Modules 199, 202
Parallel Stations 200, 202
PC Elements 27, 29
PC part 248, 250

INDEX (continued)

PM640 23, 35, 132, 314
PM644 23, 35, 133, 320
PM645 23, 35, 134, 328
PM646 23, 35, 135, 339
Power distribution units 352
  SX540 352
  SX542 352
  SX554 352
Power supply 139
  Connection 66
  module
    SA610 35, 68, 139, 224, 288
  units
    SA161 351
    SA162 351
    SA171 140, 351
    SA172 140, 351
Power-up 107
Process Connectors 79
  TF610 79
  TF620 79
  TK630 79
  TK640 79
Processor modules
  PM640 23, 35, 132, 314
  PM644 23, 35, 133, 320
  PM645 23, 35, 134, 328
  PM646 23, 35, 135, 339
PROFIBUS-DP 155, 172, 227
Pulse Counting 152
R
RC 610 5, 20
RCOM 169, 227
RE500 Cabinet, power dissipation 188
Redundancy 192
  1 out of 2 CPU configuration 203, 207
  1 out of 2 Station Redundancy 195
  2 out of 3 Station Redundancy 195
  configuration 22
  CPU Redundancy 194
  PC elements, DB elements 198
  program change 116
  SA610 70
  test module
    89RT01 117
Redundant Modbus 207
Redundant Processing 193
Relay module
  89AR30 202
Replacement 301
RF615 85
RF616 35, 85
RF620 35, 86
Rotational speed 326, 337
S
S600 I/O 142, 148
  capacity 226
  Module 82, 83
  protection class 75
  signal paths 144
S800 I/O 142
  signal paths 144
SA161 139, 351
SA162 139, 351
SA171 140, 351
SA172 140, 351
SA610 35, 68, 139, 224, 288
Safety
  Regulations 49
  Shut-down 100
SC610 88
Sequence Control 183
Siemens 3964R 170, 227
Software 21
  OPT 1 29
  OPT 12 29
  OPT 4 29
Start Modes 241
Stop program execution 101
STOP-Mode 109, 241

INDEX (continued)

Submodule carrier module SC610 88
Submodules
    CI532 88
Subracks
    Dimensions 231
    RF615 85
    RF616 35, 85
    RF620 35, 86
SX540 352
SX542 352
SX554 352
System
    Clock 212, 223
    Power Supply 224
    Software 248
    States 245
T
TC513 164
TC514 164
TC610 73
TC630 164
Terminal unit
    TX650 45
Terminator for I/O extension bus
    TC610 73
Test Facilities 114
TF610 79
TF620 79
TK610 74
TK612 35
TK615 35
TK630 79
TK640 79
TK661 201, 202
TK662 195, 197
Tracking 198
    planned 205, 208, 209
    unplanned 204
    values 167
Turbine modulating control 196
Turbine Protection 201
TX650 45
U
Upgrade System Software 104
W
Working Modes 242
Y
Year 2000 compliant 9

3BDS 005 555R101

April 2000